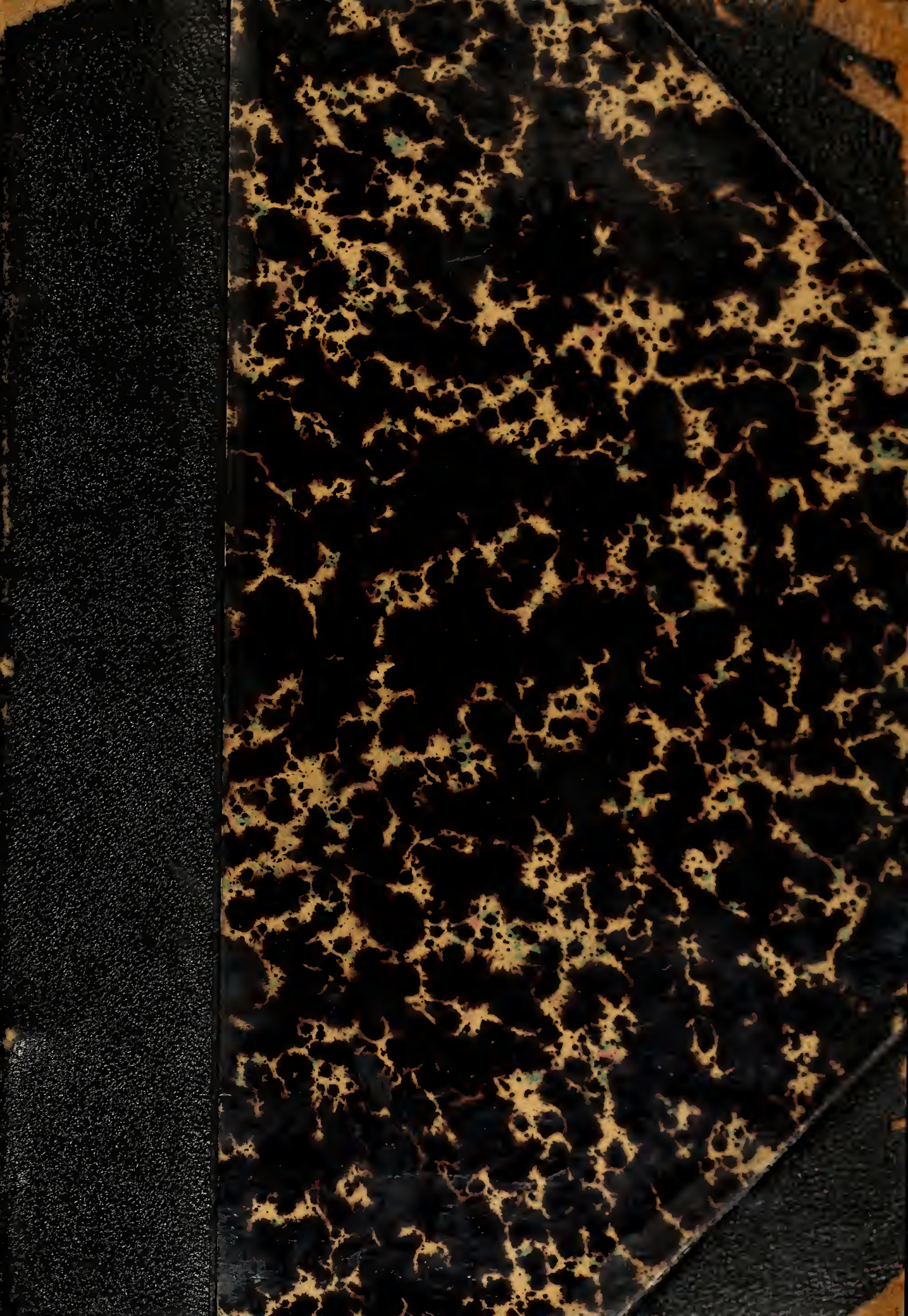
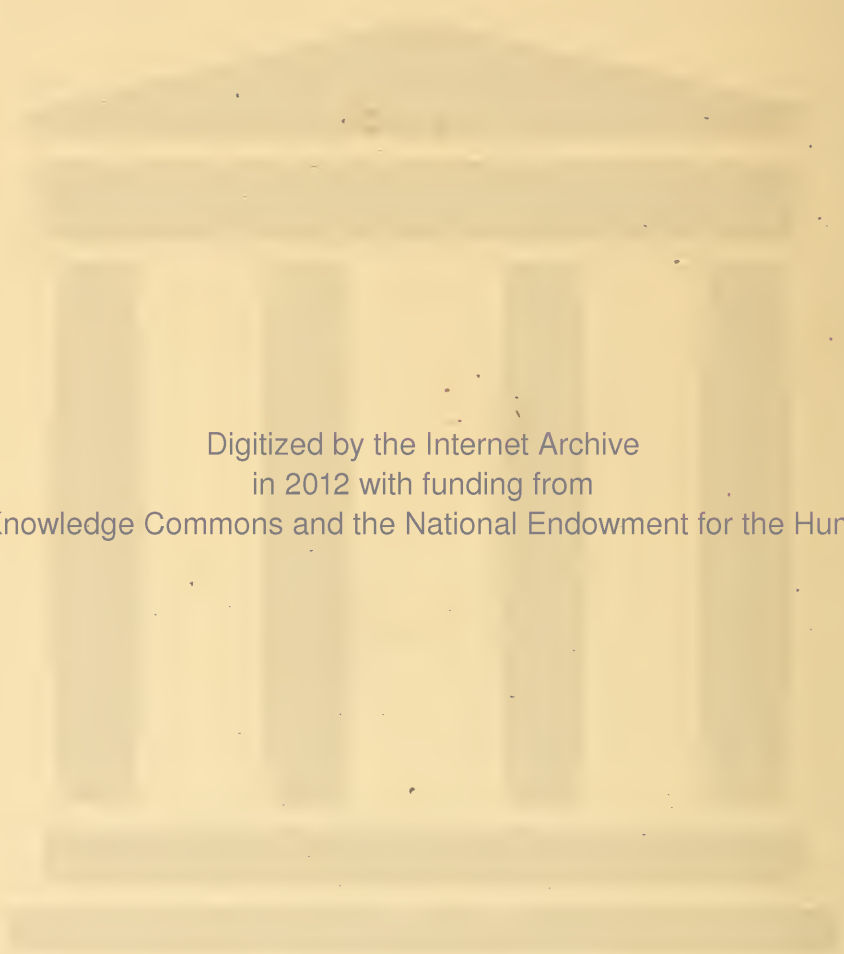




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Medical Communications

OF

THE MASSACHUSETTS MEDICAL SOCIETY

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ARTICLE I.

The Annual Discourse.

THE BURDEN OF FEEBLE-MINDEDNESS.

BY WALTER E. FERNALD, M.D
OF WALTHAM.

DELIVERED JUNE 12, 1912.

NOTE.—At an Adjourned Meeting of The Massachusetts Medical Society, held Oct. 3, 1860, it was

Resolved, "That The Massachusetts Medical Society hereby declares that it does not consider itself as having endorsed or censured the opinions in former published Annual Discourses, nor will it hold itself responsible for any opinions or sentiments advanced in any future similiar discourses."

Resolved, "That the Committee On Publications be directed to print a statement to that effect at the commencement of each Annual Discourse which may hereafter be published."



THE BURDEN OF FEEBLE-MINDEDNESS.

MR. PRESIDENT AND FELLOWS

OF THE MASSACHUSETTS MEDICAL SOCIETY:

The methods of patient research and collective investigation which have led to such brilliant results in the study of various diseases in general medicine and surgery are now beginning to be applied to the study of the causation, extent, significance, treatment and prevention of feeble-mindedness — the synonym of human inefficiency and one of the great sources of human wretchedness and degradation.

The past few years have witnessed a striking awakening of professional and popular consciousness of the widespread prevalence of feeble-mindedness and its influence as a source of wretchedness to the patient himself and to his family, and as a causative factor in the production of crime, prostitution, pauperism, illegitimacy, intemperance and other complex social diseases.

The exact number of the feeble-minded in the community is not known. There are probably 2 to 1000 of our population, over 7000 in this State alone. These cases are found in the families of the rich and of the poor, in the city and in the country. There is scarcely a village or a school district in this State where one or more will not be found. There is no reason for believing there is a greater proportion in this State than in other states or countries.

The fact that feeble-mindedness is the result of pathological conditions of the brain, either gross lesions caused by faulty development or by the destructive results of disease, or perhaps numerical deficiency or imperfect evolution of the

ultimate cortical cells, makes it obvious that the resulting mental defect is incurable and permanent. If a nerve cell is damaged or destroyed by traumatism or disease, it is gone forever. It is never replaced by the multiplication of other similar cells, as may happen in other bodily tissues.

The various known causes of feeble-mindedness occur in two main groups — the hereditary and the accidental. The hereditary cases are those where the person is feeble-minded because his parents or other ancestors were feeble-minded. The accidental group includes those who are feeble-minded as a result of environmental causes, without hereditary influence.

The hereditary cases are the most numerous. The recent intensive study of the family histories of large numbers of the feeble-minded by Goddard, Davenport and Tredgold show that, in at least 80 per cent of these cases, the mental defect had been preceded by other cases of defect in the immediate family line. Goddard finds that 65 per cent of his institution cases had one or both parents actually feeble-minded. It is believed that this hereditary defect is the result of protoplasmic defect in the germ plasm of the family stock.

There is no doubt as to the potency and certainty of this hereditary tendency. Often the feeble-minded child represents a feeble-minded family. Davenport believes that aside from the Mongolian type, probably no imbecile is born except of parents who, if not mentally defective themselves, both carry mental defect in their germ plasm.

So far as is known, if both parents are feeble-minded, all the offspring will be feeble-minded. If one parent is feeble-minded, it is probable that some of the offspring will be feeble-minded, and the children who are themselves normal will be likely to beget defectives. These normal persons in tainted families who are potential "carriers" of the defective germ plasm may keep up the sequence. If both parents come from tainted families, the probability of defect in the

children is much increased. The normal members of tainted families who mate with healthy individuals with no family taint are not so likely to have defective children; indeed, the tendency may be eradicated by judicious breeding-up for several generations. This tendency may be expressed by one or more cases in every generation, or it may skip one generation to reappear in the next. Inheritance is not merely a question of fathers and mothers, but the family tree goes farther back.

Among the probable accidental or environmental causes of feeble-mindedness are injuries to the head at birth, blows or falls in infancy, inflammatory brain disease, toxemia from infectious diseases, abnormal mental or physical conditions of the parents, etc., or the absence of certain vital substances from the blood, as in cretinism. Cases of feeble-mindedness often occur in families where there has been no mental disease or defect for several generations, but even where the exciting cause is undoubtedly accidental, there is often a strong hereditary predisposition. Similar injuries or causes in sound families do not result in feeble-mindedness. In the majority of these cases the environmental causes are only accessory. The real origin of the disease lies in the defect of the germ plasm.

Certain types of defect are usually if not always due to accidental or sporadic causes, viz., the Mongolian, hydrocephalic, post-meningitic, the cerebral hemorrhagic, etc. Acquired characteristics are not likely to be transmitted, but there is reason for the belief that alcoholism, syphilis, tuberculosis and other environmental factors may initiate germinal variation which may become hereditary. The cases of purely accidental origin with no morbid heredity are not likely to be followed by other cases in that family. The purely accidental cases themselves would probably beget normal progeny.

To sum up, there is a large number of feeble-minded per-

sons in our community. The great majority of these persons are feeble-minded because they come from a stock which transmits feeble-mindedness from generation to generation in accordance with the laws of heredity. Many of the members of these families are not defective themselves, but to a certain extent these normal members of tainted families are liable to have a certain number of defectives among their own descendants.

There is a popular belief that feeble-mindedness is greatly on the increase. We do not know, and are not likely to know, whether or not there is now relatively more feeble-mindedness than there was fifty or one hundred or five hundred years ago. There is some reason for the belief that the remarkable shift of population from rural to urban conditions in the last half-century, with the resulting industrial and social stress, and a greater liability to syphilis, tuberculosis and alcoholism, has increased the ratio of defectives in the families with hereditary predisposition. It is certain that the feeble-minded girl or woman in the city rarely escapes the sexual experiences that too often result in the birth of more defectives and degenerates. At the same time the steady withdrawal of the more sturdy and virile individuals from the country to the towns leaves the ineffective and defective men and women in the country to marry and beget offspring even less efficient than themselves. Recent study of certain isolated rural communities in this State where the more vigorous families have migrated for several generations shows a marked deterioration in the quality of the population, with a large number of the feeble-minded and a notable amount of immorality, intemperance and shiftlessness. The defective persons in these communities are very apt to be attracted to each other, and to marry or to intermarry, thus intensifying the degenerative process. The members of this society are only too familiar with these rural foci of feeble-mindedness, immorality, crime and destitution.

The social and economic burdens of uncomplicated feeble-mindedness are only too well known. The feeble-minded are a parasitic, predatory class, never capable of self-support or of managing their own affairs. The great majority ultimately become public charges in some form. They cause unutterable sorrow at home and are a menace and danger to the community. Feeble-minded women are almost invariably immoral, and if at large usually become carriers of venereal disease or give birth to children who are as defective as themselves. The feeble-minded woman who marries is twice as prolific as the normal woman.

We have only begun to understand the importance of feeble-mindedness as a factor in the causation of pauperism, crime and other social problems. Hereditary pauperism, or pauperism of two or more generations of the same family, generally means hereditary feeble-mindedness. In this State there are families who have been paupers for many generations. Some of the members were born or even conceived in the poorhouse.

Every feeble-minded person, especially the high-grade imbecile, is a potential criminal, needing only the proper environment and opportunity for the development and expression of his criminal tendencies. The unrecognized imbecile is a most dangerous element in the community. There are many crimes committed by imbeciles for every one committed by an insane person. The average prison population includes more imbeciles than lunatics. The term "defective delinquent" is applied to this special class of defectives where the mental lack is relatively slight, though unmistakable, and the criminal tendencies are marked and constant.

At least 25 per cent of the inmates of our penal institutions are mentally defective and belong either to the feeble-minded or to the defective delinquent class. Nearly 50 per cent of the girls at the Lancaster reformatory are men-

tally defective. The class of "defective delinquents" of both sexes is well known in every police court, jail, reformatory and prison. There is a close analogy between the defective delinquent and the instinctive criminals who form a large proportion of the prison rounder type. Under present conditions these irresponsible persons are discharged at the expiration of their sentences to lay tribute on the community, to reproduce their own kind, to be returned to prison again and again.

A very large proportion of the neglected and dependent children in the care of the State are feeble-minded and are the offspring of the feeble-minded.

Many of the immoral and diseased girls found in rescue homes and shelters are defective and absolutely incapable of reform or of self-support. Many prostitutes are mentally defective. A large proportion of the mothers of illegitimate children at Tewksbury and elsewhere are feeble-minded. In one county almshouse in Pennsylvania there were 105 mothers of illegitimate children, and of these mothers 100 were feeble-minded.

A majority of the parents prosecuted by the Society for the Prevention of Cruelty to Children for abuse of their own children are feeble-minded.

In England 70 per cent of the habitual drunkards who are dealt with under the "Inebriate Act" are mentally defective.

The modern intensive study of the family trees of individual degenerates, the insane, epileptics, criminals, prostitutes, hereditary paupers and the feeble-minded has emphasized the fact that these various conditions of degeneracy are often merely different phases or expressions of the same fundamental inferiority. In these degenerate families the form of defect varies from generation to generation, feeble-mindedness in one generation, pauperism or criminality in the next, and then some form of insanity, alcoholism, etc.

It has been truly said that feeble-mindedness is the mother of crime, pauperism and degeneracy. It is certain that the feeble-minded and the progeny of the feeble-minded constitute one of the great social and economic burdens of modern times.

The realization of these truths and the recognition of the strong tendency to hereditary transmission has produced a sort of panic on the part of those who have just learned of these facts. Visions of a feeble-minded peril in future generations are seen, and have resulted in a "wild panic for instant action." There is no occasion for hysterical, ill-considered action.

It is probable that intelligent study of the whole problem on a large scale will furnish data for adequate treatment and control. The full problem should be stated by a complete and permanent census of the feeble-minded of the entire State. This is possible by the coöperation of physicians, teachers, social workers, court and prison officials, local authorities, etc. Such registration would be analogous to the required notification and registration of contagious and infectious diseases, and would be the first step in the regulation and elimination of defective strains from the community. The State Board of Insanity has already begun an informal and tentative census of this sort.

In the light of our present knowledge, the only way to reduce the number of the feeble-minded is to prevent their birth. The perpetuation of defective family stocks should be inhibited. This would be possible to a great extent if every feeble-minded person and every potential "carrier" of the defective germ plasm could be prevented from parenthood.

There is already a strong popular demand for the logical and thorough application of our present knowledge of the laws of morbid heredity in the way of prevention. This State has begun the policy of the segregation of the feeble-

mined, especially those of childbearing age. This segregation carried out thoroughly for a generation would largely reduce the amount of feeble-mindedness. The high-grade female imbecile group is the most dangerous class. They are not capable of becoming desirable or safe members of the community. They are never able to support themselves. They are certain to become sexual offenders and to spread venereal disease or to give birth to degenerate children. Their numerous progeny usually become public charges as diseased or neglected children, imbeciles, epileptics; juvenile delinquents or later on as adult paupers or criminals. The segregation of this class should be rapidly extended until all not adequately guarded at home are placed under strict sexual quarantine. Hundreds of known cases of this sort are now at large because the institutions are overcrowded.

Only 2000 feeble-minded persons are now cared for in institutions in this State, and over 1000 applicants are awaiting admission to the institutions. There is an urgent demand for greatly increased institutional provision for this class. The cost of this provision will be great, but not as great as the present cost of caring for these same persons, to say nothing of their progeny, in future generations. It would cost less money, be more economical in social life and of immense value morally. These people are never self-supporting, but are eventually supported by the public in some way. From the economic standpoint alone no other investment could be so profitable, not even in canals or railroad or factories. The present generation is the trustee for the inherent quality as well as for the material welfare of future generations.

In a few years the expense of institutions and farm colonies for the feeble-minded will be counterbalanced by the reduction in the population of almshouses, prisons and other expensive institutions. When the feeble-minded are recognized in childhood and trained properly, many of them are

capable of being supported at low cost under institution supervision.

Not that we regard the institution as the panacea for feeble-mindedness. If adequate institution provision were available to-day, it would not be feasible to secure the detention of large numbers of defectives, and those the most dangerous class, where parents or friends are unable or unwilling to see the necessity for such segregation. We have no laws compelling this action. The Anglo-Saxon respect for the liberty of the individual would make it difficult to enact laws compelling such custody. This difficulty could be approached by the suggested registration of the feeble-minded which would afford a basis for some sort of extra-institutional supervision and control. The observed misconduct and incapacity of many of these people would soon show the need of legal provision for their forcible segregation.

In a rational policy for controlling feeble-mindedness it is essential that we recognize the condition in childhood. Our compulsory school laws bring every child to official notice. Every case of feeble-mindedness should be recorded. At the proper time the parents should be informed of the condition of the child, of the necessity for life long supervision and of the probable need of institution treatment. Sooner or later the parents will probably be willing to allow their child to be cared for in the institution. The parents who are not willing should be allowed the custody of their child, with the understanding that he shall be properly cared and provided for during his life, that he shall not be allowed to get into mischief and that he shall be prevented from parenthood. Whenever the parents or friends are unwilling or incapable of performing these duties, the law should provide that the child shall be forcibly placed in an institution, or otherwise legally supervised.

There are now special public-school classes for the feeble-

mined in most of our cities and large towns. These classes insure diagnosis and treatment at an early age, they help to inform the parents as to the dangers of the condition and they admirably serve as clearing houses for permanent segregation before adult life is reached. They should be extended and increased in number.

The mental defectives in our penal institutions should be recognized and transferred to permanent custody in suitable institutions and farm colonies and not discharged at the expiration of their sentences, to beget other defectives and to reënter their careers of crime. We now have a law in this State authorizing the permanent control and custody of this criminal imbecile class which only needs the provision of suitable buildings to become effective. No other state or country has yet made similar legal recognition of these so-called "defective delinquents." The logical application of this law would materially modify our present methods of dealing with certain classes of so-called "criminals" in the prisons, jails, reform schools and the courts. The elimination of these defectives from the prisons would increase the opportunities for reforming the normal offenders who are really capable of reform.

Compulsory surgical sterilization of all defectives is proposed as a radical method for preventing the hereditary transmission of feeble-mindedness. At least six states have passed laws authorizing or requiring this operation. In no state, however, has this remedy been applied on a large scale. There are many objections to this plan. The friends of the patients are not willing to have the operation performed. The normal "carriers" of defect would not be affected. The presence of these sterile people in the community, with unimpaired sexual desire and capacity, would be a direct encouragement of vice and a prolific source of venereal disease. Sterilization would not be a safe and effective substitute for permanent segregation and control.

It is probable that education in the broadest sense will be the most effective method in a rational movement for the diminution of feeble-mindedness. The public generally should be intelligently informed as to the extent, causation and significance by means of suitable literature, popular lectures and other means. There is now great demand for such information from women's clubs, church societies, charitable organizations, etc. General knowledge of this subject in a community will insure the rational protection and control of the feeble-minded persons in that community.

The principles of heredity, as they are unfolded, and especially of morbid heredity, should be taught in the colleges, the normal schools, and, indeed, in the high schools. The adolescent has a right to be informed on a subject which is of supreme importance to himself, to his family and to his descendants. The great majority of these young people will later marry and become parents. The dangers of a marriage with persons of diseased stock should be presented plainly. The young woman about to marry should be taught that her most important duty to herself and to her race is to choose a man of good heredity as the father of her children. The young man should be taught that the quality of the family stock of his future wife largely determines the health and efficiency and sanity of his children, and of his children's children. Those who have been privileged to address groups of young people on these subjects can but be deeply impressed with the breathless interest and appreciative understanding of their auditors.

The biological, economic and sociological bearings of feeble-mindedness have overshadowed the fact that it is fundamentally and essentially a medical question. Feeble-mindedness is a condition which is the result of certain permanent lesions of the central nervous system.

This subject should receive more attention in the medical schools. At the present time only a few schools in this

country give any instruction whatever in the subject. General hospitals and dispensaries should have out-patient departments for the diagnosis and treatment of feeble-mindedness. These clinics would also provide for the instruction of students. No medical student should graduate until he has a general knowledge of the causes, varieties, prognosis and treatment of feeble-mindedness.

Every physician in general practice will find cases of feeble-mindedness among his patients. He has the unwelcome task of informing the parents of the misfortune of their child. He is called upon to advise as to treatment and life-long care and protection.

The prevention of the accidental type of feeble-mindedness largely depends upon the knowledge and skill of the physician in recognizing and in removing or modifying the environmental conditions which may cause the defect.

The recognized field of mental defect has been gradually extended and widened, and clinical types and degrees of feeble-mindedness are recognized by the alienist which are not yet familiar to the medical profession generally. It is most important that the physician should recognize the so-called "borderline" cases, where the intellectual defect is apparently slight, and is overshadowed by the immoral and criminal tendencies. These cases may be glib and plausible, often bright-looking and attractive, but are unable to apply themselves at school or at work without constant supervision, and are wholly indifferent to the consequences of their behavior and actions. The inability to get or keep a situation or to support themselves is most significant. These cases often present a bad family history, a personal history showing backwardness in infancy and school life, and the presence of various physical stigmata of feeble-mindedness. Psychological tests of these adolescents or adults show that they have a mental age of only seven or eight or nine years. In fact, they are cases of real feeble-

mindedness differing only in degree and not in kind from the more obvious varieties.

The growing appreciation of the medico-legal bearings of feeble-mindedness, the increasing tendency of the courts to inquire into the mental status of persons accused of crime, and the widespread movement to recognize and treat mental defect in the public schools have created an urgent demand for the services of physicians skilled in the diagnosis of mental defect which cannot be met at the present time. Indeed, the social worker, the charity visitor, the teacher and the court official often recognize cases of feeble-mindedness which they are unable to properly treat and control because they cannot secure the coöperation of suitably qualified physicians. A medical diagnosis of feeble-mindedness is necessary before a case can be properly or legally considered.

If, as we believe, the prevalence of feeble-mindedness can be most effectively reduced by educational methods, the remedy largely depends upon the medical profession. The physician has knowledge of family histories and tendencies. He has access to family councils. His advice in individual cases is eagerly sought and generally followed. He has exclusive opportunity to teach and inculcate certain accepted principles of practical eugenics.

The most important point is that feeble-mindedness is highly hereditary, and that each feeble-minded person is a potential source of an endless progeny of defect. No feeble-minded person should be allowed to marry, or to become a parent. The feeble-minded should be guarded or segregated during the childbearing period.

The normal members of a definitely tainted family may transmit defect to their own children, especially if they mate with one with similar hereditary tendencies. These potential "carriers" of defect should mate with sound stock, if they marry at all. If the hereditary tendency is marked and

persistent, the normal members of the family should not marry. Certain families should become extinct. Parenthood is not for all.

Persons of good heredity run a risk of entailing defect upon their descendants when they marry into a family with this hereditary taint. Intelligent people are often willing to forego a proposed marriage if the possibilities of heredity are fully understood. The immediate sacrifice is less painful than the future devoted to the hopeless care of feeble-minded children. What can be more tragic than the familiar cry of the agonized mother, "If I had only known?"

The well-informed physician has the pleasant privilege of allaying the fears of those who misinterpret and magnify the possibilities of morbid heredity in their own families. It should be remembered that a single case of defect of accidental origin, with no hereditary tendency, is not likely to be followed by other cases in the same family. Indeed, a case of this sort may be found in a family where the other members are of exceptionally brilliant and gifted mentality. The ordinary family is safe and sound and whole, and is extremely unlikely to produce feeble-minded children.

In the annual discourse for 1907 Dr. Adams said: "A medical practitioner is, to a greater or less extent, a missionary. He is always finding and doing some work, unpaid or underpaid, for his fellowmen, because his training and his position make such work possible and natural. In all philanthropic measures he is to be relied upon as a helper, and in those pertaining to public health he is naturally a leader. He has unequalled facilities for disseminating knowledge, for awakening interest and for guiding benevolence. The evidences of this influence are to be seen on every hand."

The imminent problem of dealing effectively with this burden of feeble-mindedness presents a fertile and pertinent field for the exercise of these extra professional activities and obligations of the medical practitioner. The commu-

nity looks to him for education and guidance on this subject. Concerted action by the medical profession will surely create the strong public sentiment which will demand a prompt and effective plan for the proper care of all the feeble-minded of the State, and for the elimination of feeble-mindedness so far as that is possible.



ARTICLE II.

The Shattuck Lecture.

THE CLINICAL STUDY OF RESPIRATION.

BY DAVID L. EDSALL, M. D.
OF ST. LOUIS.

DELIVERED JUNE 11, 1912.



THE CLINICAL STUDY OF RESPIRATION*

IN the past few years the study of particular functions and of their disturbances has become so conspicuous that in the most active fields of clinical research it has largely taken the place of the study of diseases as entities. In other words, we have come much more generally to recognize diseases, whether clearly organic or apparently functional, as made up of a group of disturbances of function, and have recognized that these disorders of functions must be clearly appreciated individually before we can comprehend any disease as a whole. It is through this change of conceptions that general physiology, physiological chemistry, the study of the normal reactions of immunity and similar questions have become so lively a part of clinical investigation. Not many years ago the physiologist was, so to speak, the mere acquaintance of the medical and surgical clinician, while the pathologist was his constant companion. Now in his daily work, the physiologist is quite as important to him as the pathologist and in dealing with those conditions whose lesions are obscure or of quite uncertain character the physiologist is essential in gaining any further comprehension of whatever disease is under study, since, in such instances, we are limited in our investigation to the study of those disorders of function that are evident. Indeed in nearly all conditions pathology itself now approaches physiology so closely that, at the present day, pathological investigation begins rather at the point where physiological processes

* Based upon studies made in the Nutrition Laboratory of the Carnegie Institution of Washington. Boston, Mass.

become deranged than where disease terminates in death, as was earlier the more general custom. The vast importance from the practical standpoint of this change of conception depends, of course, upon the fact that almost all our methods of treatment, as well as diagnosis, really deal not with diseases as such but with the predominating disturbances of function that diseases produce. The influence of the newer point of view upon the methods of treatment may be illustrated by so familiar a disease as typhoid fever. When I studied medicine, I was, essentially, taught certain routine methods of treating typhoid fever, which were varied in character somewhat according to the severity of the disease but were really directed chiefly against the disease as an entity. Now we are taught to treat the patient's powers of resistance, his excretion, his disturbances of circulation, digestion and metabolism but, as to the disease itself, only certain characters and accidents that are somewhat peculiar to this disease.

Through the physiological viewpoint the clinical study of disease has added to it a wealth of new methods for determining the exact character of changes in the pulse, the blood pressure, the functional capacity of the heart, the secretory and motor activities of the digestive organs, the functional capacity of the kidneys and a variety of other things, and as a consequence our methods of diagnosis and treatment have been altered and improved to a degree that is but vaguely comprehended by any of us unless we consider in detail the changes that have occurred in the last two or three decades. Some of these methods have become essential parts of careful routine study of individual patients. Some are too complex to be capable of serving widely as clinical aids, and are useful almost solely in research. The purpose of research is, however, twofold — the introduction of new individual methods and the development of new conceptions, and the greater of these is the latter. The

strong tendency exhibited by all of us to judge of the usefulness of a piece of research by the readiness with which particular methods employed in it can be immediately introduced into the routine examination of patients is, of course, erroneous. The greatest service any methods render is not this, but the general enlightenment they bring to our conceptions of the diseases with which we are dealing. Many of these methods would not long be used in practice even if their technique were made suitable, not because the methods are valueless, but because when they have established new conceptions it is frequently easy to recognize clinically by simple methods what previously could not be comprehended by any methods.

Let us consider what has happened in regard to the study of respiration during the time that the study of the circulation, the renal function, the digestion, metabolism, the blood and many points in regard to the nervous system has been so actively followed, and has yielded so much of clinical value. It is a striking fact that the great function of respiration has received very little clinical study, excepting in direct relation to questions of metabolism and this work has been in large part physiological rather than directly clinical. We have increasingly exact means of diagnosing the actual lesions within the chest that may be associated with changes in respiration, and we have long recognized that certain pronounced changes in respiration occur in association with certain diseases, and that some of these changes are indicative of individual, more or less serious, conditions. But we have not in any striking way added much in recent years to our knowledge of the meaning or the importance of the abnormal forms of respiration seen in disease, and still less has been added to our means of relieving them. Contrary to our method of dealing with most other disturbances we still confine ourselves in our routine observations of the respiration of patients almost entirely to the extremely

valuable, but in some ways recognizedly insufficient and inexact, methods that have for the better part of a century been in use by careful observers, and even in precise and systematic clinical investigations much the same methods are employed.

Instruments have been devised for recording clinically, with greater precision and in greater detail than can be done by ordinary observation, the characters of the respiratory movements and changes produced in them by disease. These have some value, but all that have been employed have decided errors associated with their use, and the information that they yield is, in most instances, slight as compared with the labor spent in securing results, though the Marey instrument has recently been so simplified that it is now almost as easy to use as an ordinary sphygmograph. These instruments have had little vogue, though some interesting, and in part significant, facts have lately been pointed out as a consequence of their use by Hofbauer and others, and the recent interesting study of irregular forms of respiration, especially in their relation to meningitis, reported by Conner of New York, is of practical importance. But in using these instruments we are dealing with conditions quite comparable to those met in the use of a simple, old-fashioned sphygmograph. Both instruments are made on somewhat similar principles, their use involves some important errors that cannot be well controlled and the instruments yield data that control accurately, among a variety of variable factors, only the rate of the pulse or of the respiration, whichever we may be studying; to a much less accurate degree, and purely qualitatively, not quantitatively, the character of the various phases of the pulse or the respiration and their amplitude. The uses of such instruments are likely to be little wider than those of the simple sphygmograph. Various earlier attempts were made to employ them clinically, but they failed to lead to their extended

use or to add any very broad facts. Recently interesting spirometric observations have been made by Bohr, Rubow and others that throw some light upon the character of the disturbances of respiration in emphysema, cardiac disorders and other conditions. These studies will add further facts of value in all probability, but they of themselves also attack but one of a number of variable factors. There have also been important observations recently on the alterations in the composition of the alveolar air in a variety of conditions, and these will probably add valuable information, though exaggerated value has certainly been placed upon their diagnostic importance by some writers.

The point that I would emphasize is that in our daily clinical observations of respiration, while we recognize the relation of some abnormalities to certain disorders, we have extremely little knowledge of the efficiency of the various forms of respiration in accomplishing the great objects of this function, namely, to carry air to the pulmonary alveoli and out again, and thus to take in oxygen and to eliminate carbon dioxide, and we have had but limited knowledge of the reasons why one form of respiration is so frequently assumed under certain abnormal circumstances, other forms under other circumstances. In other words, we do not know the real causes of these abnormalities of respiration, and, until the causes are learned, it is impossible to determine their real significance. Until both cause and significance are known we cannot attempt to treat them intelligently. The truth and importance of this statement is reflected in the fact which I think all clinicians will admit, that except in a very limited number of types of conditions, chiefly essential asthma and circulatory disorders that are capable of being much benefited, we can do very little to relieve respiratory distress, and even in those conditions mentioned our results are often highly unsatisfactory. No drugs are more sadly disappointing when we most desperately need them than

those that are classed as respiratory stimulants. I shall come back to this point later, and indicate means by which I trust it will be possible to search at least for more accurate and more efficacious methods of treating some of these disturbances. I will at present go back to my statement that our usual methods of clinical study give us no accurate idea of the real extent of respiration in most cases, the real result, that is, that respiration is accomplishing. I think the tendency of most clinicians will be to doubt this statement at once, but if any one will, with a suitable instrument, measure the ventilation with different types of breathing, he will, I am sure, find, as I have, that it is frequently no easier by ordinary methods of observation to tell with any accuracy what one form of respiration accomplishes as compared with another, than it is to tell with approximate accuracy with one's finger what the blood pressure is, or by looking at a person, about what his blood count is, especially when we attempt to determine the real or alveolar ventilation making allowance for the so-called "dead space" in the chest, a factor which it is important that clinicians should appreciate more thoroughly than we have done. This point, too, I shall take up more specifically later. Even when one makes observations on one's self, the confusion that arises from differing rate and differing amplitude of respiration, and from the varying sense of effort connected with respiration and from all sorts of combinations of these factors renders it impossible to judge with any accuracy what is being accomplished. In observations which I have made upon myself and other subjects, when I have thought from ordinary observation that more was being accomplished in one way than in another, or that the reverse of this was true, the records often showed the contrary, except, of course, in instances in which the difference was too gross and apparent to permit of mistake.

The frequency of minor or even marked alterations of

respiration is appreciated only when attention is specially given to them. Irregularities of rhythm of varied kinds, alterations in rate and in amplitude, changes in the relation between costal and diaphragmatic breathing are all very frequent. Regarding even the most striking of them we know very little. What is accomplished by the slow, deep respiration frequently seen in cerebral, and some other, disorders as compared with its opposite, the rapid, superficial breathing so common in severe pulmonary disease, in many infectious diseases, in bad cardiac cases and in other states, and why these have so strong a tendency to occur in some circumstances and not in others are questions that have been very imperfectly answered, indeed in many ways little touched upon. The reason that in one set of diseases and often in one group of normal persons the rate of respiration varies in relation to the amplitude in one way and in another group in the contrary way, a question recently studied from the physiologist's standpoint in an interesting manner by Hough, is in one sense almost the same question, but in another sense is rather a distinct question, and the answer to it is not clear in either case. The preponderance of costal breathing in one case and of diaphragmatic in another case is readily explained if abdominal inflammation, effusions, or growths, or certain diseases of the chest are present, but if they are not, its occurrence needs explanation. The prevailing idea that costal breathing predominates in woman by a provision of nature in preparation for pregnancy must, it seems from a variety of investigations, be largely relinquished for the much less mysterious view that it is a habit acquired through her long established custom of wearing constricting clothing. But if an habitually abnormal method of breathing can be established in this way without producing distress, it only argues that when it occurs without this cause there must be some other occasion for it. Possibly a strong hint as to the meaning of it in some cases can

be seen in Lewis' apparent demonstration that costal and diaphragmatic breathing have the opposite effect upon blood pressure. He finds that costal inspiration, contrary to ordinary statements, lowers systemic blood pressure, while abdominal inspiration raises it. Lewis' observation that the so-called paradoxical pulse is in minor form entirely normal and not paradoxical at all appears to be correct, and is important as pointing out a widely prevalent error promulgated through earlier erroneous observations. The importance that too great a predominance of costal over diaphragmatic breathing may have is shown by Weckebach's striking studies of a series of cases which were chiefly simple splanchnoptosis. These exhibited such serious disturbances of the circulation that this able student of the circulation was led at first to consider that grave myocardial weakness was present, but the trouble proved to be due, apparently, solely to low position of the diaphragm and inability to exert an effective pumping action upon the blood in the abdominal vessels and viscera, — that pumping action which is so important a factor in the normal maintenance of the circulation.

Some of the disturbances of respiration mentioned, as well as others, occur frequently. We have, as I have said, learned that they are often associated with certain diseases, and in some instances really indicate somewhat the presence of certain definite lesions, but the actual reason for their occurrence is usually not clear.

Physiologists have done a very great deal of work in recent years upon respiration, and in certain ways this work has been of important significance to the clinician. I shall make no attempt to review the great numbers of facts that have accumulated, but there are a very few conspicuous points that I would refer to, in that they bear especially upon directly clinical questions, and in part upon observations of my own that I wish to discuss. In its breadth of clinical

significance that work which has borne upon the manner in which the respiratory center is excited is most important, especially since clinically we are too prone to think directly of mechanical conditions in the chest or changes in the circulation as producing alterations in respiration and too likely to think of them as acting through nervous impulses. In diseases of the nervous system we often give consideration to influences exerted more directly upon the respiratory centre but we do this too little in other circumstances.

In normal circumstances respiration appears to be excited not by nervous impulses coming from the thorax or other distant sources, but by chemical means carried by the circulation or developing in the tissues about the centre itself. The conditions in disease are more complex and the character of the respiration is then often determined to a large extent directly by mechanical or circulatory changes within the chest. Nevertheless even in disease the dominant factor remains usually the chemical conditions surrounding the respiratory center, and a sharper appreciation of this fact will lead us to a better understanding of many respiratory abnormalities. It has long been known that, contrary to a widely prevailing impression, the CO_2 in the blood is quite as important as the oxygen in regulating respiration, but recently Haldane and his co-workers have made it appear very probable that the altogether predominating factor in exciting the respiratory centre in normal circumstances, is CO_2 — not its total quantity in the blood, but the quantity present in such form as to exert gaseous pressure, a very important distinction that is often overlooked in criticizing Haldane's work. They find that the tension of the CO_2 in the blood is kept under normal circumstances within extremely narrow limits. A very slight increase in it excites respiration. Increase tends, of course, to occur constantly and this is normally met by regular respiratory activity. On the other hand, a fall to even slightly lower points is

followed by cessation of respiration. These investigations have offered evidence from a variety of standpoints that CO_2 tension is normally the only stimulant to respiration, and that lack of oxygen becomes a stimulant only in a secondary way, and when very severe. Whether this is altogether true or not (which is not finally settled), their explanation of the pronouncedly periodic character of that striking phenomenon, Cheyne-Stokes respiration, is the only good one that has yet been offered, and is of great interest clinically, as it makes it easier to comprehend the fact that this form of breathing tends to occur especially in certain types of severe disease, but nevertheless is, in some degree, seen at times in a rather disconcerting way that is difficult to understand, in perfectly simple conditions, even, for instance, in normal sleep. Hal-dane and Douglas found, as was known long before, that if they breathed for a time very rapidly and deeply, there occurred pauses in breathing, owing to the fact that an excess of CO_2 had been pumped out by the forced breathing, and the CO_2 pressure in the blood had consequently fallen below the point where it excites the respiratory center. If, after severe forced breathing, they breathed just as they desired pauses occurred and were followed by occasional rhythmic breathing which assumed a crescendo form, then by a fall, then another pause and then a repetition of the phenomenon; in other words, Cheyne-Stokes breathing. The conclusion they reached after various experiments was that Cheyne-Stokes breathing is in such experiments due primarily to the presence in the blood of too little CO_2 to excite the respiratory center, or in disease usually to a reduced sensitiveness of the center to CO_2 , so that this substance accumulates without exciting the center and hence the pauses in breathing occur. During these apneic pauses the oxygen in the blood decreases, and a point is reached where the great lack of oxygen whips the center into action either directly or through consequent derangements of body

chemistry, accumulation of lactic acid being suggested as the immediate excitant of the periodic breathing efforts. Increasing lack of oxygen is followed by the periodic, rapidly increasing breathing efforts up to the point where sufficient oxygen has entered the circulation to permit the center to lapse off again into quiet, when another pause follows, and then the phenomenon occurs over again. This makes readily comprehensible the occurrence of Cheyne-Stokes breathing in cerebral stupors and in stupefying toxemias which would have the effect of dulling the respiratory center, and it would also render it easier to understand the occasional occurrence of typical or nearly typical breathing of this kind in sleep, and in other normal or nearly normal circumstances. It occurs in sleep chiefly, I think, when people are lying on their backs and this together with differences in the respiratory center in different people may help to explain the occurrence of this breathing. The dropping backward of the tongue that often occurs in deep sleep tends to prevent the entrance of air, and the respiratory center being relatively insensitive naturally in some persons as compared with others, we may conceive that in such persons, especially in the semiconsciousness of sleep, there would not be any response to the increasing CO_2 or to the lack of oxygen until the demand for oxygen and accumulation of CO_2 reached a high point, and then the phenomenon would appear. That posture may at any rate play an important part is indicated by the fact that I have repeatedly observed that Cheyne-Stokes breathing consequent upon severe organic disease, such as cerebral hemorrhage, will sometimes, though by no means always, disappear if the patient is turned from the back to the side. That the respiratory center differs greatly in its sensitiveness in different people is indicated by a number of physiological studies made by Haldane and his co-workers, Hough and others, but is perhaps best illustrated in this connection by the fact that normal persons,

even when awake, in unusual instances exhibit more or less distinct Cheyne-Stokes breathing, and in a normal man, whom I have seen, showed at times, in tracings taken with the apparatus that I shall describe later, breathing of this character when lying on his back awake; the phenomenon disappeared when he lay on his side. I am indebted for these observations to Mr. T. M. Carpenter of the Carnegie Nutrition Laboratory. He had been studying some curious irregularities of CO_2 output in this man, that proved to be due to the irregularity in breathing. I mentioned to him the fact that even Cheyne-Stokes breathing may disappear when a person is turned on his side. Mr. Carpenter subsequently studied this man when he was lying on his side and noted that most of the irregularity both in respiration and in CO_2 output disappeared under these circumstances. In the absence of all other explanation I think the conditions in this case must be attributed to a peculiarity of the man's respiratory center which permits of more marked and prolonged changes in oxygen and CO_2 tension in the blood than are possible in most persons without exciting respiration. The fact that his center is relatively insensitive as compared with normal persons is shown further by the fact that distinct and sometimes long expiratory pauses are present regularly in the tracings of his respiration when the latter is most regular, indicating that his center responds only slowly to the normal stimulus. The improved breathing when he is lying on his side may be due to the fact that the opening of the glottis is more free then, or it may be due to local changes in circulation about the respiratory center, or there may be other factors.

In this country, especially, clinical interest in the relation of CO_2 to respiration has recently centered to a large extent around the work of Yandell Henderson, which has been of great value in indicating the clinical importance of studies of respiration of a type that had not previously been appre-

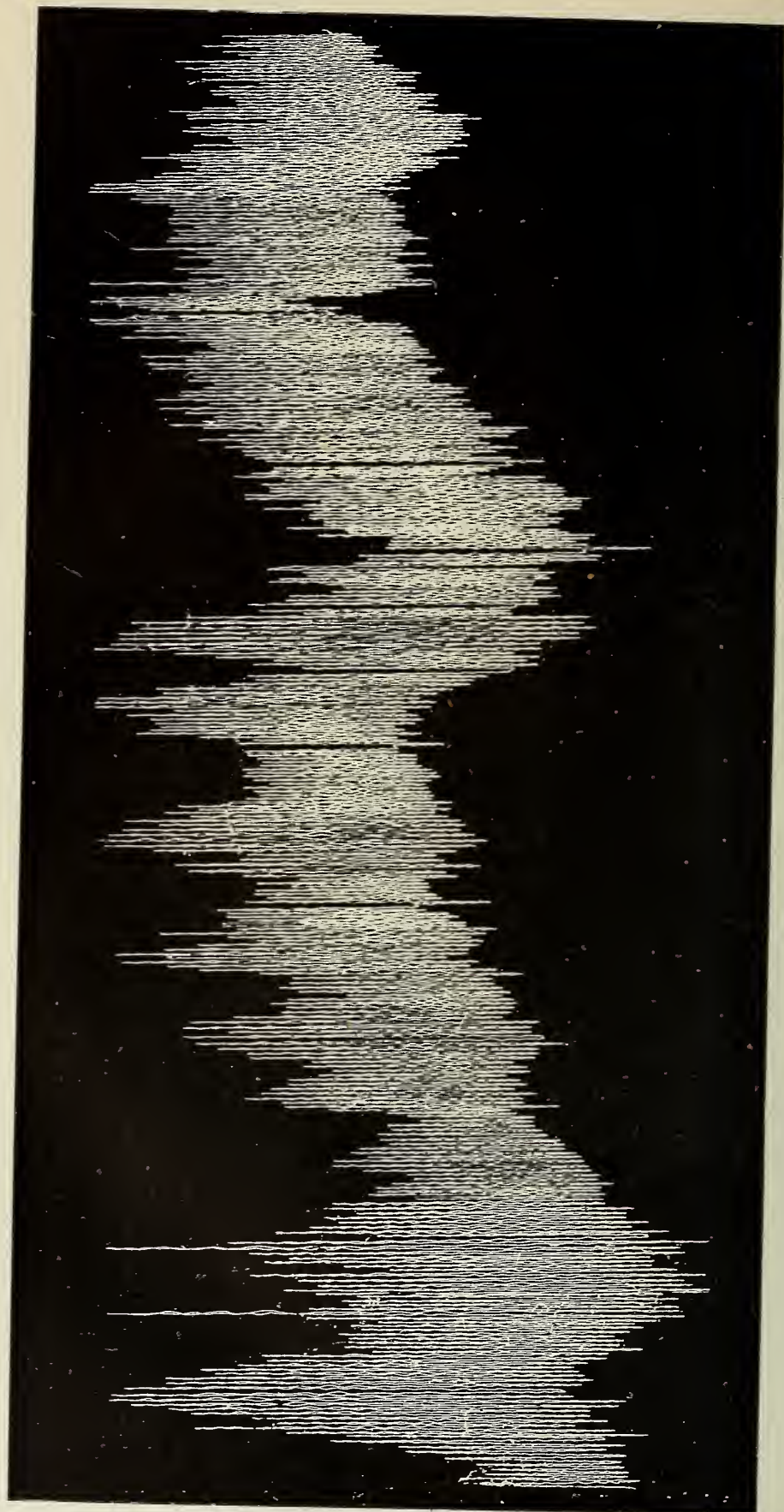
ciated by clinicians. Henderson has pointed out the possibility, in the first place, that the violent respiration that occurs at times from severe pain, fright or other emotion, and during ether anesthesia may be the cause of the cessation of breathing that so frequently occurs in the course of operations and that in occasional instances becomes very alarming and may, of course, end fatally. The explanation is, he believes, simply that in the increased breathing so much CO_2 is pumped out that the automatic stimulus to respiration ceases, and in the absence of consciousness the patient of course makes no voluntary effort to breathe. Of still broader interest is Henderson's further suggestion that shock is due, in some cases, at least to excessive pumping out of CO_2 in forced breathing, or to excessive diffusion of CO_2 from exposed coils of intestine. He has contributed a series of experimental studies in support of his view that the phenomena of shock follow great loss of CO_2 , and that the occurrence of shock can be traced to this in many clinical instances. The first of his suggestions that I mentioned we undoubtedly need to heed until it is determined how important it proves to be. It is well established that apnea, or cessation of breathing, occurs for short periods after very moderate forced breathing, and for longer periods when the deep breathing has been more marked, and, as Henderson suggests, alterations in the sensitiveness of the centre due to the anesthetic or to other factors may make this much more important under the circumstances of operations than is normally the case. It is, I think, the experience of many skilled anesthetists that the apnea usually follows excessive breathing. Certainly at present it is desirable that even greater care than is customary in regulating the breathing in anesthesia be employed. The occurrence of apnea after forced breathing and the active voluntary effort that is required to overcome it is shown well by some accompanying tracings. In these and the other tracings the up-stroke

is inspiration, the downstroke expiration. No. 1 is a normal tracing, No. 2 was taken during forced breathing, as was No. 3. In the last, in spite of urgent efforts to continue the forced breathing regularly, though it had not been very excessive, the man lapsed frequently into apnea and the breathing became quite irregular, owing to the large loss of CO_2 that he had suffered. In the fourth period he breathed as he felt inclined, and that tracing shows very irregular breathing with superficial respirations separated by periods of apnea and with distinct periods of Cheyne-Stokes, all due to the preceding loss of CO_2 .

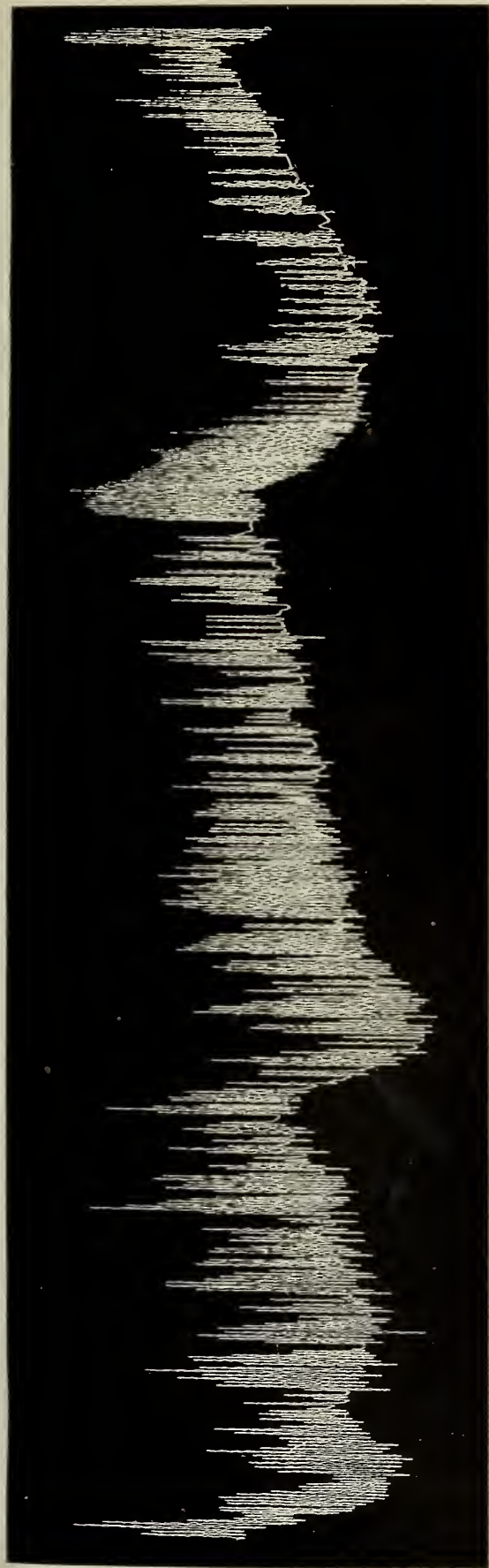
As to the importance of loss of CO_2 in the production of shock I am more skeptical. This question was extensively discussed by the American Physiological Society from a general physiological standpoint last winter, and a number of important reasons were advanced against Henderson's views. I cannot take the time to review this discussion, but would mention that the results of experiments which I recently undertook for another purpose are opposed to his beliefs. I had normal men breathe normally for 15 minutes, then rapidly and deeply for 15 minutes; then a second 15-minute period of excessive breathing; and this was then followed by a 15-minute period in which the breathing was just what the subject wished. I determined the oxygen intake, the CO_2 output and the total air inspired in each period. The amount of air taken in with each respiration, as well as the general character of each respiration, could also be precisely determined from quantitative tracings of the respiration taken coincidentally. All these important variable factors were determined by means of a very valuable apparatus devised by Dr. Francis G. Benedict, of the Carnegie Nutrition Laboratory. I am deeply indebted to Dr. Benedict for providing me not only with the use of this apparatus, but also with many other facilities in his laboratory, and for constant advice in my work while there.



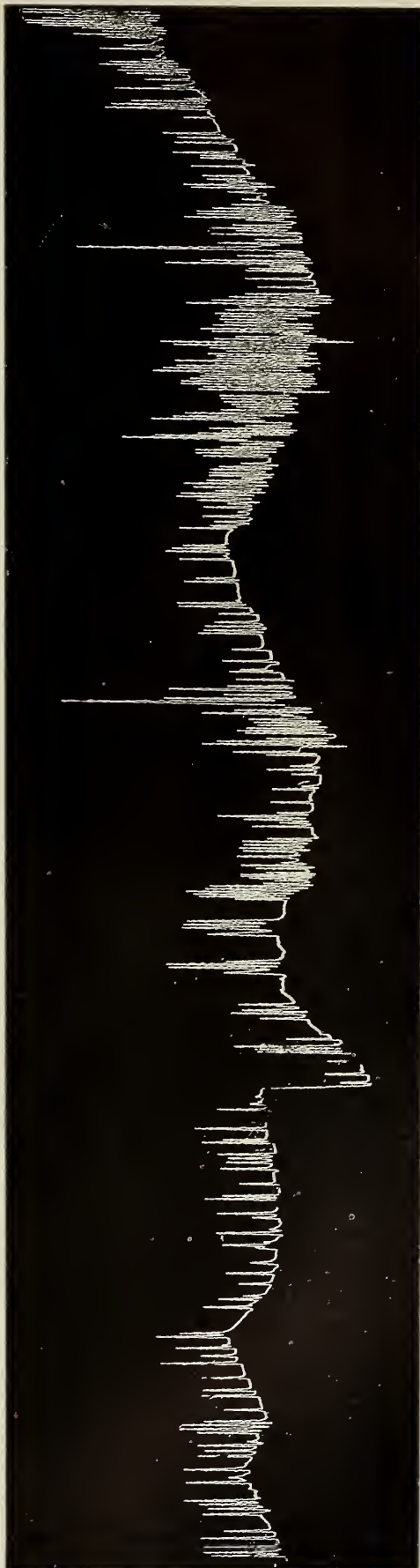
No. 1. Normal tracing. The two very deep inspirations are purely accidental and without significance. The extended changes in level in this and other tracings are due to absorption of oxygen from the apparatus and its readmission. In all the tracings the upstroke is inspiration, the downstroke expiration.



No. 2. Forced breathing.



No. 3. Taken directly after No. 2. Forced breathing frequently interrupted by apnea.



No. 4. Taken directly after No. 3. Cheyne-Stokes periods and simple apnea. Marked variations in rate and amplitude.



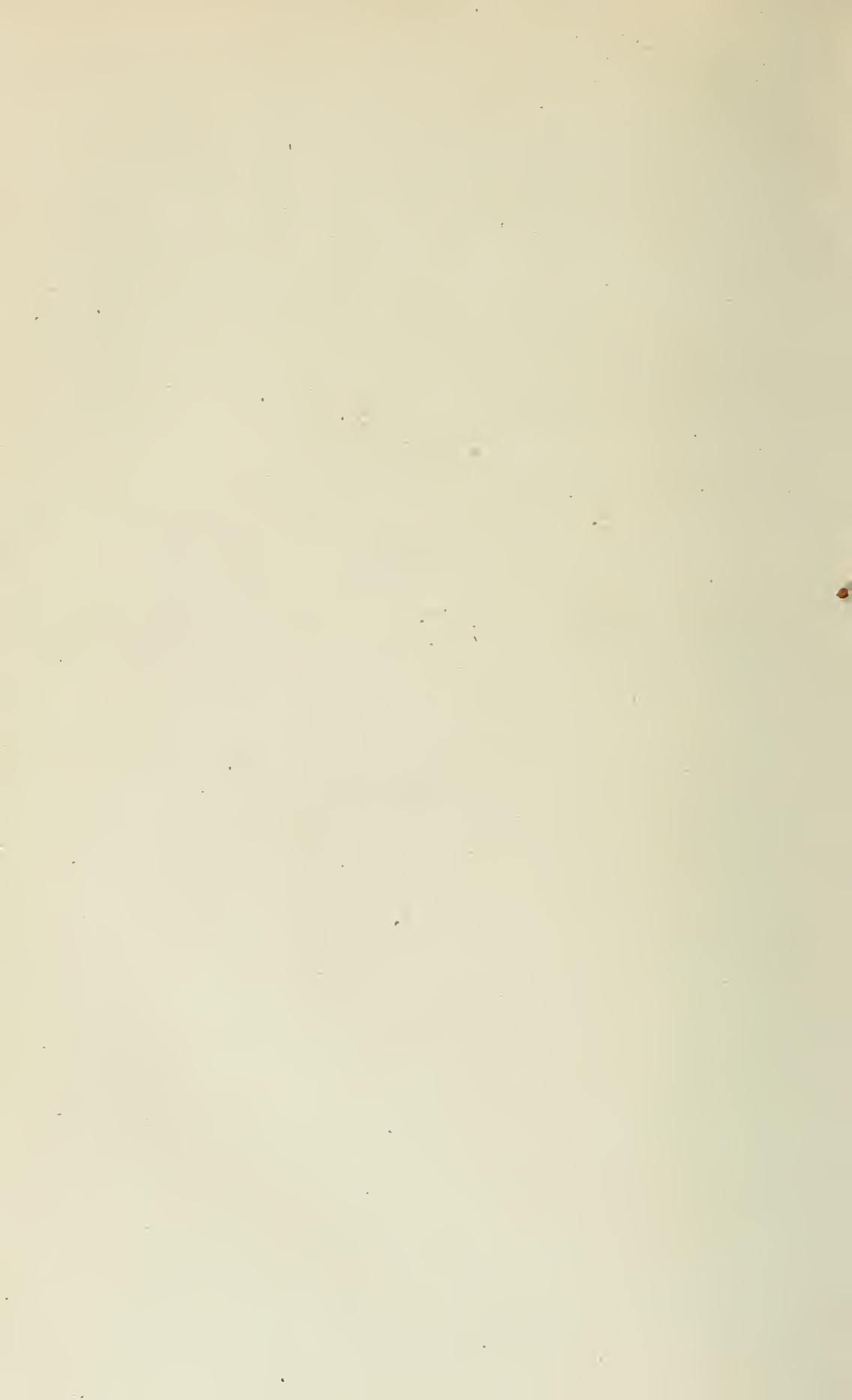
No. 5. Shows chiefly a long period of apnea at the beginning of rest from forced breathing.



No. 6. Great irregularity of rate and amplitude after forced breathing.



No. 7. Superficial, mildly apneic breathing, at times rhythmic, following forced breathing.



The apparatus has been described by Dr. Benedict. It consists, briefly stated, of a closed system of tubes, into which the subject breathes. The air contained in the system is kept in constant circulation by means of a blower. The CO_2 is continually absorbed by soda lime and its amount is determined simply by the increase in weight of the soda lime container, while the oxygen absorbed is determined by admitting enough oxygen to bring the pressure in the system to the original amount, and reading from a meter the amount of oxygen necessary to accomplish this. A spirometer of the bell type constitutes part of the system. The movements of the bell are recorded quantitatively by means of a workadder and the amount of air entering the spirometer and hence the amount respired are thereby determined. The rod carrying the counterweight to the bell carries also a writing needle which gives tracings of the respiration on a revolving drum, and, since this needle moves upward or downward exactly as much as the bell, the value in air respired can be accurately determined for each respiration by measurements of the tracings.

In addition to the factors mentioned that I determined by this apparatus, I took the pulse rate, and observed any symptoms that occurred, and Dr. Harold L. Higgins of the Nutrition Laboratory kindly made for me coincidentally in a considerable number of these and other experiments determinations of the blood pressure (with the Erlanger apparatus) and of the CO_2 of the alveolar air, using a modification of Plesch's method of securing the alveolar air, and the Haldane gas analysis apparatus. In these experiments the forced breathing actually lasted over 40 minutes in all instances, and sometimes over 50 minutes, owing to time consumed between periods in arranging for the next period, during which time the excessive breathing was continued. The extent of the forced breathing was, I am sure, much greater than I have ever seen in that length of time, or in

a much longer period, from pain, anesthesia, or fright or during shock. In some instances the ventilation throughout the fifteen minute periods of excessive breathing was as much as five times the normal. It resulted in a great excess in the output of CO_2 , repeatedly more than doubling the normal output, and in some instances causing a loss from the body of much more CO_2 than the whole amount of blood in the body contains, most of the excessive output coming, of course, from the other fluids and the tissues which contain even more CO_2 than the blood. Some of the most marked losses of CO_2 (that is, the amount eliminated in the two forced breathing periods over and above the amount eliminated in the normal period) were as follows: 4.54, 4.72, 5.53, 6.55, 6.78, 7.04 and 8.11 liters. The oxygen consumption showed that this excessive output of CO_2 was in but small part due to increased metabolism. In other words it was CO_2 that was simply pumped out by the forced breathing. This loss gave rise to the symptoms usually produced by prolonged forced breathing: tingling and numbness in the extremities, in some instances actual severe brief spasm in the hands, feet, forearms and legs, giddiness, headache, which was at times prolonged for an hour or two, and in the rest period superficial respiration, more or less marked pauses in breathing and usually mild or distinct Cheyne-Stokes breathing. Tracings 1 to 4 are from one of these experiments. These symptoms were never at all alarming, but they can become so unless care is used. The men who acted as subjects for me were much interested in the experiments and usually wanted to force the breathing much harder than I wished, in their desire to get more striking results, and they often had to be actually restrained in order both to avoid bad results and to accomplish the purposes I had in view. In spite of this great loss of CO_2 , and these pronounced symptoms, none of the men showed any signs of shock. The blood pressure remained essentially unaltered. This

statement must be made with some reservation in regard to the period of forced breathing, because of the difficulty in making exact observations during such efforts, but in the after period of complete rest, in the early part of which the effects should have been most marked, the results must be considered reliable, and showed, as compared with the normal period, usually no noteworthy change, and at most only about 5 mm. difference from the normal in diastolic pressure, and usually less than 10 mm., once or twice 25 mm., difference in systolic pressure during the forced breathing. In all instances any change observed was a rise in pressure during, and apparently due to, the effort in the forced breathing. The pulse rose with the increased effort at first, and sometimes continued high during the forced breathing, but more frequently it fell after a time in spite of continued forced breathing, and during the after period of rest it almost invariably fell even well below the normal, gradually approaching normal again coincidently with increasing accumulation of CO_2 in the blood and perhaps as a consequence of this accumulation. Indeed, the evidence I have would suggest, though there are several reasons why I am not sure of this, that reduction of CO_2 tension in the blood directly reduces the heart rate while increase of it increases the heart rate, the latter point being suggested also by other knowledge that we already have. This is opposed to Henderson's observations but his methods of experimenting may have caused an increase in pulse rate from other causes than the loss of CO_2 . It appears to me possible that CO_2 tension has a direct or indirect hormone influence upon the heart — that it is one of the pace makers for the heart. At any rate, the pulse did not show the characteristics of shock but rather the contrary. None of the subjects showed any of the general symptoms of shock. That the CO_2 tension of the blood was actually low was shown by determinations of the CO_2 in the alveolar air. Owing to the rapidity with

which CO_2 passes through the pulmonary alveolar walls, the tension of the CO_2 in the air contained in the pulmonary alveoli is practically the same as that in the venous blood in the lungs and therefore determinations of its tension in the alveolar air indicate directly its tension in the venous blood. The fall in CO_2 tension consequent upon the forced breathing was very decided. It repeatedly fell to about 50% of the normal, or even a little lower. Examples (expressing the amount of CO_2 in percentages of an atmosphere) follow: In one instance it fell from 4.94 to 2.68, in another from 6.75 to 3.19, in others from 5.91 to 3.61, from 6.26 to 3.28 and from 6.94 to 3.42. I think that if shock is likely to develop simply from pumping out CO_2 , some at least of these men should have shown it in some degree. There are probably important elements of truth in Henderson's views, but for the reasons that I have given, as well as for other reasons, it appears reasonably clear that loss of CO_2 alone is not a sufficient explanation of shock. If this is the case, I should feel that we need to be very cautious in employing, as he has recommended, and as has to some extent been done, inhalations of CO_2 to replace that supposedly lost, as a treatment of shock. It is readily possible that such inhalations might produce bad results; and if there had been no noteworthy loss of CO_2 , as is not improbably often true in shock, they would be the more likely to be harmful. I would repeat, however, what I said earlier, that the immediately utilitarian application of investigation is usually far less important even to the clinician than the new conceptions that it leads to, and whatever may prove true of its details this work of Henderson has already been of great value in bringing into close touch with clinical problems methods and conceptions that previously had but little clinical significance and it will have increasing importance from this standpoint. His suggestion that CO_2 be used in the treatment and prevention of dangerous apnea in operations and under other

circumstances is a matter to be looked at separately, and deserves to be studied thoroughly, though much care should be exercised, of course, in investigating it in human subjects until it is more clearly determined what its value and dangers may be.

I wish now to refer to some experiments with the same apparatus that I undertook for other purposes, namely, to determine if possible the relative results accomplished by some of the different types of breathing so commonly seen in disease. With myself and others as subjects breathing first normally, then superficially, then as slowly and deeply as possible without distinct discomfort, I determined the CO_2 output, the oxygen intake and the total ventilation, in fifteen-minute periods, and made measurements of the records of the individual respirations. In each experiment the deep and the superficial breathing were kept down to the lowest amount possible without producing distinct respiratory distress, in order to make it as nearly certain as possible that the demand for air was, in each instance, being just met, and at any rate not exceeded. Otherwise I should of course have been entirely unable to tell whether these periods could properly be compared with the normal, as it would have been impossible to have told whether we had not breathed much more than necessary. In the abnormal forms of breathing we avoided as far as possible any use of the accessory muscles of respiration, a point of importance in interpreting the results.

In most instances we had the impression of having breathed less in total amount during the period of superficial breathing than in the other periods. In every instance quite the contrary was true. The record always showed in the neighborhood of 25 per cent more total (tidal) ventilation in this period than in the normal period and the lowest amount of air used was always in the slow deep breathing; as much as 25 per cent less than in the normal period and as much as

40 per cent less than in the period of superficial breathing. Evidently, then, from the standpoint of gas exchange the slow deep form of breathing is very economical of effort while the superficial form is extremely wasteful.

It is easy to explain why this is true and at the same time the difference becomes emphasized to a rather astonishing degree if we consider the influence of the "dead space." The dead space means, of course, that space in the chest into which, with each respiration, air enters and passes out again, but comes in contact with no areas in which any considerable amount of diffusion of gas occurs to and from the blood, the space, that is, in the upper part of the respiratory tract. How far down towards the alveoli its limits should be put is not wholly clear as some diffusion appears to occur through the walls of at least the smaller bronchi. Entrance and exit of air into this space is a waste so far as any direct influence upon gas exchange is concerned, and each respiration must, therefore, have the dead space counted out from the amount of air apparently taken in if we wish to know how much is really efficient in increasing gas exchange. It becomes apparent immediately that the influence of the dead space is much more important in the rapid superficial forms of respiration than in slow, deep breathing, as a little consideration will show at once. Various figures are given for the size of the average dead space. All are to some degree approximate. Used as an average those most commonly accepted are the figures of Löwy, and make the average capacity about 140 c.c. I have taken these figures as a standard factor in calculating the effect of the dead space. Now suppose, for example, that a man breathing deeply takes in 1800 c.c. of air with each respiration, and breathes only four times a minute. He takes in a total of 7200 c.c. each minute. Counting out 140 c.c. of dead space for each of these four respirations, viz. 560 c.c. all told, we have left 6640 c.c. of real or alveolar ventilation.

If this man at another time breathes with a normal rate and amplitude, taking in 450 c.c. of air each time, and breathing 16 times a minute, his total ventilation is the same, 7200 c.c., but we must take out the dead space 16 times, viz. 16×140 , or 2240 c.c. and we have left only 4960 c.c. That is, the deep slow breathing would give in this instance 33 per cent more real or alveolar ventilation than the more rapid type of breathing which in this instance, however, is the normal type. The difference would be still more marked with a more superficial type of breathing. If he breathed 32 times a minute, taking in 225 c.c. each time, he would again have 7200 c.c. tidal air but 4480 c.c. must be deducted now so that only 2720 is alveolar ventilation. As compared with this form of breathing the slow deep form with only four respirations per minute would give 144 per cent more alveolar ventilation. This helps, it would seem, to show why in the panting respiration following active exertion an occasional deep breath is so grateful, and why patients with cardiac and other severe disease so often break a rapid, superficial type of breathing with a deep sigh or gasp. The deep breath does the work of a surprisingly large number of superficial ones but the deep breathing cannot be kept up continuously, probably because of the greater mechanical strain it causes upon the circulation.

The figures that I obtained in a typical example of the experiments that I am now discussing are shown on page 42. In this instance, then, the superficial form required over ten times the number of respiratory efforts that the slow, deep form did, and 2.6 times the number of efforts required by the normal form, but the results in CO_2 output and in the oxygen intake were very close to each other in all instances. There is a slight reduction, in the deep breathing period, in the output of CO_2 and a slighter rise in the oxygen intake in both the superficial and deep breathing periods, but this latter rise was due, I think, entirely to the fact that, as I

said, in all these experiments an effort was made to keep the respiration down somewhat, and this together with the effort to maintain a form of breathing to which we were unaccustomed, led to extra effort, chiefly to a constant tendency to slight action of the accessory muscles of respiration. That there was slight suppression of the respiration is shown by

Breath- ing.	Respirations.		Ventilation.		Alveo- lar, CO ₂ .	CO ₂ output.		Oxygen absorbed.	
	Aver- age per min.	Total, 15 min.	Aver- age per min.	Total, 15 min.		Aver- age per min.	Total, 15 min.	Aver- age per min.	Total, 15 min.
Nor- mal ..	11.6	174	liters 6.21	liters 93.25	← 6.43	c.c. 257	c.c. 3850	c.c. 304	c.c. 4580
			—	24.36					
			4.59←	→68.89					
Deep.	2.7	41	4.76	71.51	← 6.76	234	3517	320	4800
			—	5.88					
			4.37←	→65.63					
Super- ficial.	31	465	8.70	130.60	← 6.81	257	3867	314	4720
			—	65.10					
			4.36←	→65.50					

← Dead space.

←→ Alveolar ventilation.

the records for the CO₂ in the alveolar air. These are slightly higher in both the superficial and the deep form of respiration than in the normal period. But the CO₂ output and the oxygen intake, as well as the figures for the alveolar CO₂, are so close as to serve as good indications of the fact that the three periods can properly be compared with one another as having accomplished just about the same result.

The most striking fact of all, perhaps, is that the real amount of air that reached the alveoli was almost exactly the same in all instances. Much the same results were ob-

tained in all experiments of this sort that I conducted, the alveolar ventilation being in practically all instances within about 5 per cent of the same amount in all the periods in each experiment. Evidently in whatever way we breathe, nature requires of us only a definitely essential amount of alveolar ventilation, and if other conditions remain the same this amount is the same, but the number of breathing efforts required to accomplish this ventilation varies extremely widely with different forms of breathing. It is often stated, especially by physiologists, that very deep breathing is wasteful of effort. My results show precisely the contrary. This is, however, due to the fact that such statements refer to deep labored breathing in which much extra muscular effort is used in each respiration. As I stated earlier I was dealing with deep unlabored breathing and purposely excluded any violent effort.

What, then, is the explanation of the occurrence of these different types of breathing? The abnormally deep form of breathing can, upon theoretical grounds, be readily thought of as being due to one of two things. It may be due to a loss of the vagus influence upon respiration, the vagus appearing, from the work of Scott and others, to restrain the depth of respiration within normal bounds, or it may be the consequence of simply a dulling of the sensitiveness of the respiratory center, so that it responds only after long intervals and then meets the accumulated demand by a deep respiration. Neither of these alone seems altogether satisfactory. It is somewhat of an assumption to say that loss of vagus control is responsible, for complete loss of vagus control appears to result not simply in deep, but also in labored, breathing; and too we have in many of these cases no other direct evidence that vagus influence is disturbed. On the other hand, if it were due simply to insensitiveness of the respiratory center, it is not clear why the breathing should be so regular in amplitude in many instances of this kind,

and not tend to assume the Cheyne-Stokes characters. It is not improbable, however, that either of these influences may produce this result at times. They may also work in combination and also other factors may come into play. Furthermore it may be that other influences than a reduction in CO_2 tension, or oxygen tension, or in the sensitiveness of the respiratory center, are necessary to lend the Cheyne-Stokes characteristics, for Haldane and Douglas' theory while explaining the periodicity does not give any satisfactory explanation of the crescendo-diminuendo character of Cheyne-Stokes respiration. It would seem, however, that those abnormal forms of breathing that show only slow respiration with decided pauses in expiration or distinct periods of simple apnea and those which exhibit Cheyne-Stokes character may often, if not always, be due to causes that differ simply quantitatively not qualitatively, for forced breathing may be followed by either or both of these abnormal forms of breathing. The readiness with which one form merges into the other after forced breathing, the fact that the one cause may produce either or both forms even in the same person and that all varieties and all intermediate stages from slight periods of simple apnea to marked Cheyne-Stokes breathing may follow this same cause are matters of decided clinical interest and significance and must render us somewhat cautious of laying great stress upon the qualitative differences seen clinically in respiratory arrhythmias until we know more about their actual causes. Some of the accompanying tracings illustrate the variability in the character of the respiratory irregularities following excessive breathing. No. 5 shows, immediately at the beginning of the rest period following two fifteen-minute periods of forced breathing, prolonged apnea. For three and a half minutes there is but one breath of considerable size and a few scarcely large enough to overcome the dead space. In fact there was during that period less than a liter of alveolar ventilation

while the same man had about 4.6 liters of alveolar ventilation per minute under circumstances differing only in the absence of preceding forced breathing. After this he took a good-sized double breath and then the respiration became very superficial for some time gradually increasing in amplitude to about normal for him, but there were few and only slight further periods of apnea, no Cheyne-Stokes and no other marked irregularities in either rate or amplitude. No. 6 is from the same man under the same circumstances but from another experiment. It shows continuously very great and erratic irregularity of amplitude and rate but few actual marked pauses though there is strong tendency to the other features of Cheyne-Stokes. No. 7 is characterized chiefly by very superficial breathing with marked pauses between breaths, the size of the pauses and of the breaths varying a good deal. Later in the tracing there occur slight periods of crescendo breathing but separated, as is chiefly the case in No 6, not by apnea, as in typical Cheyne-Stokes, but by tachypnea. This was after one of the most severe experiments, but the results in the character of the breathing are less marked than in other experiments. In No. 4 there is superficial breathing with marked apneic pauses, also typical short periods of Cheyne-Stokes and other periods showing the Cheyne-Stokes type of breathing minus the apneic periods. In all these the subject breathed simply as he desired without voluntarily influencing the character of his breathing.

The superficial type of breathing in disease seems to me susceptible of more definite explanation than the slow deep form, and comprehension of it would be of much more frequent clinical importance. It occurs chiefly in certain toxemias, infectious or other, and in severe circulatory weakness, aside from those instances in which it is simply neurotic. It appears highly probable that excessive accumulations of CO_2 , or of other (chiefly unknown) substances that, besides CO_2 are almost certainly active in disease in exciting the

respiratory center, irritate the center excessively in such conditions and produce increased frequency of respiration. Indeed the center in many of these cases, when they are severe, is probably continuously irritated, and hence there is a demand for a new respiratory effort almost constantly. There are also other reasons for the occurrence of this breathing in severe circulatory distress. Such breathing may readily modify favorably for the failing heart the frequency and extent of the well-known suction and compression effects of respiration upon the blood stream in the thorax and abdomen that have been so well described by Tigerstedt. While the actual influence upon these of any particular changes in respiration is rather complex and it is difficult to postulate definitely whether the influence would be good or bad in particular types of cases, there is one point that seems to me to deserve more direct attention than I have seen definitely given to it. Rapid breathing, in lessening the extent of the changes in pressure in the thorax and abdomen that occur in respiration, certainly reduces, as compared with slower breathing, the extent of the variations in systemic blood pressure that are the normal and inevitable consequence of the usual respiratory changes in intrathoracic and intraabdominal pressure, and experimentally very rapid breathing appears even to wipe out entirely the general blood pressure changes. It may readily be an important source of relief to the heart, when under severe strain or very incompetent, to be freed of the marked variations in strain that occur with decided changes in blood pressure. Increase in respiratory rate from any cause would, however, if carried far, make respiration itself tend to become inefficient or at least make it do much more work in accomplishing the same result, as my figures indicate, for if there is marked increase in the rate, the amplitude of respiration suffers, and amplitude has more influence on the end result than has the rate. This may easily establish just the same

type of vicious circle as occurs under certain circumstances with the heart. With the latter organ, when the rate increases, the amplitude of the stroke tends to become deficient and hence when working inefficiently, but rapidly, under strain the heart often tends to race still faster because of its failure to accomplish its function, the failure being due to insufficient amplitude of stroke. In racing it makes an ineffectual, and always increasingly hopeless, attempt to make greater rate take the place of amplitude. We have good reason to consider that respiration also often tends to increase in rate at the expense of amplitude when the center is severely excited. This is clearly indicated by Hough's recent experiments on the different influences in different normal persons of breathing into an enclosed space in which the CO_2 constantly accumulates. In most of his experiments after a time — sometimes very early — the rate increased and usually at the increasing expense of amplitude. Besides the effect of overstimulation of the respiratory center the rate is, in all probability, hastened to an unduly great extent in many instances in the struggle that I mentioned to make mechanical conditions in the chest favorable to the circulation. The more respiration races, the more muscular labor it costs and the less it accomplishes with a given amount of labor.*

* Kraus' studies of the effects of work upon the respiration of persons with incompetent hearts, and others, have been interpreted as showing that in cardiac cases the amplitude of respiration increases under moderate strain as much as, or more than, the rate, just as it does in normal persons. In the cases that he studied, which were relatively mild cases of cardiac weakness, the amplitude did at times increase proportionately during work but this was not always true, and these cases are, at any rate, not comparable with those I refer to in which there is severe incompetency even when there is no unusual strain and in these amplitude often suffers. Furthermore, in most of Kraus' cardiac cases the amplitude of respiration was abnormally low even when there was no physical strain and although in some it did increase with work, the result accomplished in such cases with a given increase of amplitude is, because of the greater effect of the dead space in superficial breathing, not as marked as a proportionate increase of amplitude in individuals who start with a normal or even greater degree of amplitude.

The experiments I have described appear to me to make reasonably clear a much discussed question which has been rather obscure and which has a good deal of significance clinically not only because of its individual importance but because of its bearing on a large subject, that is, the manner in which morphine accomplishes its effects in many cases of respiratory distress, and especially in cases in which this distress is due to badly failing heart. It has been very hard to understand why a drug which is not a circulatory stimulant should cause such an evident and often such a rapid improvement in the circulation as it sometimes does. A simple general sedative action and the consequent rest afforded does not seem a sufficient explanation of the striking and rapid change in the circulatory picture often seen, nor are the other explanations that have been offered very satisfactory, and it is most of all difficult to understand why an apparently hopelessly failing respiration should be so greatly relieved by a powerful respiratory depressant. If, however, the center is in these cases really overexcited and is dulled in sensibility by the administration of morphine, and thus respiration changes to a slower pace, this, as has been generally recognized, would of course greatly reduce muscular labor, but it would do this far more than has been appreciated and if it would, at the same time, tend to result in respiration actually accomplishing a great deal better its own function and thus help to relieve the respiratory center itself of strain, and likewise rapidly eliminate an excess of CO_2 (and perhaps other excitants) from the blood, as well as get in more oxygen, the matter would seem to be fairly plain. But if the explanation of the hurried breathing that I have outlined above is correct, if, that is, it is due only partly to a struggle to increase the ventilation in the lungs, partly also to a struggle to make the mechanical conditions easier for the heart, it is apparent that, as is practically a fact, respiratory depressants, such as morphine, must be used

in such conditions with great care and judgment. Although both the factors mentioned had been overdoing the matter, a very pronounced slowing of the breathing might readily throw unfavorable strain upon a very incompetent heart by producing too great respiratory changes in pressure, even though the contrary source of strain (undue labor from excessive rate) were overcome and although the ventilation also improved.

Consideration of the points that I have just discussed convinces me that we certainly need to determine, as far as we can, in any pathological disturbance of respiration, when the disturbance is associated with exhaustion of the respiratory center, and when it is, on the contrary, due to over stimulation of the center. The treatment would, in the two cases, be the opposite. I think we may reasonably suspect that we have in many instances been making an error entirely similar to that which we made for years in treating the circulatory failure in acute infectious diseases with the mistaken idea that it was primarily due to excess of blood pressure whereas it is usually due chiefly to quite the contrary condition. We may, that is, in respiratory distress, equally well have been dealing at times with a condition directly the contrary of what we thought we were treating, and may, especially, very often have been treating an overexcited respiratory center by still further exciting it. Likewise it appears to me that the effects of the respiratory stimulants need, in purely experimental studies, as well as clinically, to be investigated to determine much more accurately than has been done, their effect on amplitude of respiration, as compared with rate, and to determine their actual influence not merely upon tidal ventilation but, much more important, upon the amount of air that passes in and out of the alveoli. In most of the work that has been done upon them I think their influence upon the actual respiratory function may perhaps have been judged quite as inaccurately as I believe we

often judge clinically of the effects of different forms of respiration. Even tracings of the respiration, unless made quantitatively, can give a reliable idea of the effect of a drug upon ventilation only when the effect is so very decided that there is no question of mistake. It is quite possible that we may find that some drugs that are called respiratory stimulants actually lower the efficiency of the function of respiration in some circumstances of disease and even in normal conditions, and the contrary may be true of some so-called respiratory depressants.

Whatever the fate of these suggestions that I have made, I think there can be no doubt that valuable information will be furnished by the coincident study of a large group of variable factors, in further investigations of respiration, clinically as well as in the laboratory. With Benedict's apparatus there is, in researches of this kind, the great advantage that we can, by relatively simple means, make coincident observations of the CO_2 excretion, the oxygen intake, the tidal and alveolar ventilation and the efficiency of each individual respiration. Yandell Henderson also has devised recently a very ingenious and inexpensive instrument that will apparently determine quantitatively the value of individual respiration and give the tidal and alveolar ventilation. One can, of course, add to these studies observations of changes in the circulation and various other factors. From such studies I think we may reasonably hope that in diagnosis and also in treatment we may gain some ground in the attempt to comprehend and benefit symptoms that are frequently even more trying than pain, and much less subject to relief, and that have been vastly less studied than pain.



ARTICLE III.

THE DOCTOR WHO VOLUNTEERS FOR MILITARY SERVICE IN TIME OF WAR.

BY CHARLES C. FOSTER, M.D.

OF CAMBRIDGE.

Surgeon-General Massachusetts Volunteer Militia.

DELIVERED JUNE 12, 1912.

THE DOCTOR WHO VOLUNTEERS FOR MILITARY SERVICE IN TIME OF WAR

JUST now a more intelligent interest is being taken in military matters than ever before in this country in time of peace. The government at Washington wishes to stimulate this interest, and in response to an official suggestion I have prepared this paper, hoping you might be interested in considering what lies before you when you volunteer for service, as some of you certainly will do some day.

How does the work differ from home practice?

One soon learns that in a well-conducted regiment his home work, caring for the sick, is only a small part of his duty. Sanitation, the prevention of disease in its broadest sense, becomes most important.

The first step is the careful examination of recruits, most of whom are young men of just the right age for typhoid, and not too old for measles, scarlet fever or mumps. Some or all of these diseases are practically sure to appear; and the conditions, the crowded way in which the men must live, the lack of bathing and laundry facilities and the ease with which a pest of flies can be bred greatly favor their spread.

A military camp is a city that rises in a half hour from the ground; a city of small, overcrowded houses, with no floors, no cellars, no drainage, no plumbing or water supply, no garbage-removal, no paved or drained streets. Naturally the sanitary problems are different from those at home; and, instead of water and milk, contact and flies become the chief carriers of infection.

As soon as the whole command has been inoculated against

typhoid and vaccinated, indeed sooner, the best practicable substitutes for home sanitation must be devised and installed. The water supply must be guarded; as high up stream as possible a place is selected for drawing the drinking and cooking water, and care taken that the bank shall not become polluted. Below this the horses are watered, and still lower washing is done. Sentries will probably be needed at these places to enforce orders.

Of course if the water is known or suspected to be impure, all drinking water must be boiled. Soldiers, especially recruits, do not like this, but in time they learn its importance. Very weak tea makes an excellent compromise.

Shallow ditches should be dug around each tent to divert as much of the surface water as possible; and often quite a system of ditches is necessary.

Opposite one end of the company streets and at a considerable distance, the latrines are dug; a poor method of disposal, but the only one possible in the field. Now, for the first time, we encounter the fly problem. Their breeding can be restricted in two ways. First, a shovel can be kept at each latrine, and every man required to throw a little dirt over his dejection before going away, in order to prevent flies from reaching it. A sentry will be needed for a time at least to enforce this, and the duty is not a popular one. Second, the trench may be burned out once or twice a day with straw, sprinkled with oil if you can get it. This kills maggots, sterilizes the trench and leaves such a strong smell of smoke that flies do not like the place. A combination of both methods is advisable.

At the further end of the company streets the kitchens are established, and I advise putting them as near the captains' tents as possible, as this has an excellent effect on kitchen discipline.

Before starting the kitchen fire a place should be prepared by digging a hole about two feet by four, and one foot deep,

and filling it with large stones, on top of which the fire is built. This makes a cremator on and under which all garbage and dishwater can be immediately disposed of.

Stable manure must be promptly carried away, and the ground where the horses stand occasionally burned over.

Personal cleanliness must be taught and enforced. A man thoroughly scrubbed, under orders, by a detail who have been inconvenienced by his dirtiness is an excellent object lesson.

Every night, toward bedtime, a tub should be put in each street, and a lantern hung beside it. When a man wants to urinate in the night he hates to go all the way to the latrine, especially in a storm, but soon learns to go to the tub.

Every meal prepared in every kitchen should be inspected, not only as to cleanliness but as to cooking. You cannot expect to make every company cook a Parker House chef, but you can insist that he cook such things as beans, oatmeal and stew thoroughly, and you can teach him to protect his food from flies by covering it with mosquito netting or cheese cloth; also not to keep left-over food until it spoils. One thing he must learn, namely, never to throw garbage or dishwater on the ground. Do not hesitate to put him in the guardhouse, or fine him if necessary, as the health of the whole company depends upon him.

Even when all these precautions have been conscientiously carried out, in time the ground will begin to grow foul, and camp must be moved, even if only a few hundred yards.

So far our new officer has been doing work for which his professional training has prepared him, but now he encounters something new, the detested "Paper Work," the elaborate system of records and papers which, for a time, will bother him more than everything else put together. Much has been done of late to reduce and simplify this, and to make it more practicable in the field, but a good deal is still necessary for two reasons: first, if justice is to be done between the soldier and the government, as in cases of pension claims, a n

accurate medical history must be kept; second, a medical officer is accountable for much valuable medical property, which may include not only drugs and dressings, but also horses, wagons and many other articles, for which he gives his receipt to the government, and is held responsible. He must learn what he is expected to have, how to get it, how to properly care and account for it, and finally how to get it off his hands when he no longer needs it. He will find that Uncle Sam insists that a certain thing must be done in a certain way. He may think he knows several better ways; but if he is wise he will follow the prescribed method and make no complaint. In the same way, when there are several equivalent drugs, Uncle Sam selects one of them and keeps it always in stock, and the officer is expected to use it. All this is necessary for uniformity and efficiency. When the volunteer has grasped this idea, he has taken the first step in his transition from a Doctor to a Military Medical Officer. He now finds that beside being a physician, a surgeon and a sanitarian, he must be, to some extent, a commander and an executive.

There should be attached to a regiment a detachment of twenty-four enlisted men of the Hospital Corps, for whom the senior surgeon will be solely responsible. He will have to enlist them, provide all their various items of equipment, teach them their duties, discipline them, and, in fact, transform them from raw recruits into creditable "Sanitary Soldiers," a new and most excellent designation.

By the time the surgeon has accomplished this task, he will feel himself something of a military man, will speak with authority, and will probably give his colonel much good advice.

If the colonel has confidence in his surgeon's knowledge and judgment, he will follow his advice whenever possible; but one day he will disregard it, and the surgeon will learn that the colonel is the one and only commander of the regiment, and the surgeon is his medical assistant and counsellor.

When the regiment starts on a campaign or a long march a new set of conditions arises. There is no longer danger of infected camps; the chief causes of trouble will be fatigue, exposure, unsatisfactory camping places, poorly cooked food, change of water and sore feet; but usually a marching command is healthier and more contented than when in camp.

In battle the medical officers of a regiment with the twenty-four men they have trained and, perhaps, with the band as extra litter-bearers, will establish collecting or aid stations in the rear of their own firing line, and as near it as they can find fairly good places. When the firing slackens or stops they will collect the wounded, apply first aid dressings, and attach to each one a tag telling his name, company, regiment, the nature of the wound and treatment given. The wounded man is now ready to begin his journey to the rear.

So far we have considered only the work and the medical organization as it exists within every regiment. If there were nothing more, the medical department would be of little value to an army. This was the case at the beginning of the Civil War. After a battle an army was practically obliged to stop where it was to attend to its wounded, and even then the inefficiency of the medical department caused a vast amount of unnecessary suffering. Many a man lay where he fell until he died of hunger, thirst or exposure. Others were picked up after several days, still alive, and their wounds full of maggots. The condition of some men on reaching a hospital, after a journey of several days absolutely without medical aid, was simply horrible.

In 1862 Major Letterman, a Surgeon of the Regular Army, devised a thoroughly organized system of medical aid. General McClellan, himself a great organizer, saw its value and tried to get it adopted, but the War Department at Washington was hide bound, not to say fossilized, and refused to sanction it. Finally, early in 1864, Congress by

law established it, and the system was fully and fairly tried for the first time in Grant's campaign in the Wilderness. It worked wonderfully. The fighting was continuous, day after day; the number of wounded was unprecedented, yet after every battle they were promptly collected and cared for, and the army was free to move on the next day and fight again.

The keynote of this system was a large, independent, departmental organization, under the sole control of the commanding general of the entire force, and handled by his medical representative, the chief surgeon. This idea is the basis of all systems today.

In most armies nowadays the Division is the chief fighting unit. It is a complete army in itself, comprising all the different arms of the service, and able to go anywhere and do anything. With us it consists of about 18,000 to 20,000 men, all told.

Its Medical Department is as follows:

At headquarters there is the Chief Surgeon, a Lieutenant Colonel of the Medical Corps, with two junior medical officers to assist him, and a few enlisted men of the Hospital Corps as clerks and orderlies. He deals directly with the commanding general or with the chief of staff.

There are 4 Field Hospitals, each consisting of 5 Medical Officers and 57 men.

These are under the command of a Director of Field Hospitals, who deals directly with the chief surgeon. A Field Hospital accommodates 108 patients normally, and half as many more if necessary.

There are 4 Ambulance Companies, each consisting of 5 medical officers and 79 men. These are under the command of a Director of Ambulance Companies, who also deals directly with the chief surgeon.

There is also a small wagon train carrying reserve medical supplies.

All these, beside the medical officers and men attached to regiments, make up a grand total of 978 officers and men, with 838 horses and mules.

The Medical Officer commanding this force must be a fine executive and a good soldier. He must understand military operations, and be able to plan his part in a coming action as scientifically as the chief of artillery plans his. He must know how to arrange his movements in coöperation with the fighting arms, so as to prevent confusion. For instance, it would never do for a train of ambulances carrying wounded to the rear to meet a regiment of artillery going to the front in a hurry. All these details must be thought out beforehand, and based on information obtained from the chief of staff.

The Field Hospital, usually established about three miles in the rear of the firing line, marks the rearmost limit of the Service at the Front. Back of this begins the Service of the Line of Communications. The Evacuation Hospital, larger and more permanent than the field hospitals, is established at the nearest railroad or steamer landing. It should have its own large train of ambulances, in order to promptly empty the field hospitals, leaving them free to move on with the army. It was here that Letterman's system failed, for it practically ceased at the field hospitals.

From the evacuation hospital the wounded go by hospital trains or hospital ships, two highly-specialized forms of transport, to the great Base Hospitals in home territory.

Now, Gentlemen, after hearing of this splendid organization, you may wonder why I predicted that sooner or later some of you would be called upon for service. It is because the organization exists only on paper. Only twice since the Civil War has a complete field hospital been gotten together, by taking officers and men who could be ill spared from a dozen or more different posts. They were strangers to each

other and to the work, and just as they were beginning to learn it, they were again scattered.

Last year troops were needed in Texas, and a Division was ordered to concentrate there. There was no such thing as a Division in existence, so it had to be improvised. Nearly every post in the country, from Maine to Montana, was stripped of every officer and man who could be spared; recruiting was stimulated; the troops remained in Texas several months, and at the end of that time that one Division, on which we had concentrated our efforts, had not been completed.

The available professional soldiers in this country are, and will probably remain, a mere nucleus for the army that will be needed for a very moderate-sized war, and that is why we amateurs will be needed.

But in the present state of military science, amateurs are of little use. A man must be at least a semiprofessional to be of any value. This means technical study. Any competent practitioner should quickly become a valuable Assistant Surgeon. A Regimental Surgeon has more to learn; the commander of an Ambulance Company or of a Field Hospital more yet; while a Division Surgeon must be a real medico-military expert.

You would be surprised if you knew the amount of work and study many Militia officers, both in the line and in the Medical Department, are giving. As soon as an officer begins to think things over he realizes that this is necessary, and sometimes gives more time than he really ought to take from his business. Congress has begun to appreciate this, and I believe will soon pass a militia pay bill which will wholly or partially make up this loss, and enable many good officers to continue in the service.

The sum and substance of the matter can be expressed in two propositions:

- 1st. Sooner or later we shall be needed.

2nd. We must prepare ourselves for our new duties.

The transition from Doctor to Medical Officer demands considerable technical study.

I recommend the following books to those who care to look into the matter:

Manual for the Medical Department, U. S.

Army Regulations, U. S.

Field Service Regulations, U. S.

Havard's Military Hygiene.

Handbook for the Hospital Corps, U. S.

For more advanced study:

Morrison and Munson's Troop Leading and Sanitary Service.

Sherrill's Map Reading.

Munson's Sanitary Tactics.

Straub's Medical Service in Campaign.

These can be obtained from the booksellers, W. B. Clarke Company, 26 Tremont Street, Boston.

ARTICLE IV.

BLOOD TRANSFUSION: INDICATIONS,
METHODS, AND RESULTS.

By BETH VINCENT, M.D.
OF BOSTON.

DELIVERED JUNE 12, 1912.

BLOOD TRANSFUSION: INDICATIONS, METHODS AND RESULTS

A REVIEW of the literature of Blood Transfusion, since the operation was placed on a practical basis by the work of Crile¹ and Carrel, shows that this procedure has not developed a wide use in medicine and surgery. While recent clinical experience confirms the great value of transfusion in some conditions, it has also emphasized the limitations of the operation. It is not my intention to discuss the whole subject at this time but I wish to consider a few practical points in regard to the use of transfusion and the best methods of operation.

INDICATIONS.

The broad indications for transfusion are based on the fact that transfused blood is a perfect substitute for blood lost in acute hemorrhage; in certain pathologic hemorrhages the blood has definite hemostatic properties, and in some secondary anemias it acts as a powerful stimulant to tide over a crisis in the disease.

ACUTE HEMORRHAGE.

To make good a direct loss of blood transfusion is invaluable in acute hemorrhage after injury or operation, in ectopic gestation and in the uterine hemorrhages of childbirth, miscarriages or fibroids. It is indicated in severe bleeding from ulcers in the stomach, duodenum or intestine. Typhoid patients, moribund from bowel hemorrhages, may be revived by transfusion but, even when an immune donor

is used, the procedure does not seem to alter the course of the disease or prevent a recurrence of the bleeding.

SHOCK.

In severe shock which, in a sense, is allied to hemorrhage, if we consider the condition one of intra-vascular bleeding, the transfusion of blood is more effective than heat, stimulation, posture or salt solution in relieving the vaso-motor paralysis and raising the blood pressure.

GAS POISONING.

The use of blood transfusion in gas poisoning seemed to be directly indicated by the experimental work of Crile and yet only a few cases of this kind have been reported. Carbon monoxide has a stronger affinity for hemoglobin than oxygen. When the oxygen is displaced by the formation of carbonic-oxide hemoglobin, the red corpuscle, as an oxygen carrier, is removed from the circulation as effectively as in acute hemorrhage. To restore the oxygen-carrying capacity of the blood normal red cells must be substituted for the damaged corpuscles. This requires bleeding before or during the transfusion. In gas poisoning the blood clots quickly and bleeding is not always easy in these cases.

PATHOLOGIC HEMORRHAGE.

In certain pathologic hemorrhages transfused blood has a remarkable hemostatic effect. The bleeding in these cases is supposed to be due to the lack of certain elements in the patient's blood. Transfusion corrects this deficiency and, at the same time, restores the blood already lost by the hemorrhage. In this latter respect transfusion has a distinct advantage over the injection of serum which has also proved to be of value in these pathologic hemorrhages. In exsanguinated cases to simply check the bleeding may not be

sufficient. Transfusion is required to restore the cellular elements of the blood.

Examples of this type of hemorrhage which may be benefited by transfusion are found in the bleeding which occurs in deeply jaundiced individuals, in hemophilia and in hemorrhagic disease of the new-born. As a prophylactic measure Willy Meyer² advocates the injection of human serum before operation on jaundiced cases. When severe post-operative bleeding does occur, transfusion is probably the one procedure which can save these patients. It seems logical to suppose that the effect is only permanent in those instances in which the cause can be remedied by drainage or the removal of some obstruction. The following case, which I transfused on April 21, 1912, is a good example of the usefulness of this operation in icteric conditions.

The patient was a woman who had been deeply jaundiced for four weeks before an operation on April 8, by Dr. E. A. Codman, at which a greatly distended common duct was found. Both the duct and the gall bladder were drained. There was no immediate bleeding from the operation wound. The jaundice persisted in spite of free discharge of bile. After developing a few subcutaneous ecchymoses the patient began to bleed, two weeks after the operation; the bile from the drainage tubes was replaced by bright red blood. At the same time there was a profuse bloody discharge from the uterus which lasted four days. Transfusion was done with the patient in a serious condition.

The brother served as donor. An Elsberg canula was used and the blood flowed for forty (40) minutes. The transfusion caused an immediate improvement in the patients' condition and effectively controlled the hemorrhage; the discharge from the wound changed to bile and old blood. At times it seemed as if there was a little fresh bleeding but this was not enough to affect the patient's condition. The jaundice gradually disappeared and the bleeding had not

recurred up to the time of the patient's discharge from the hospital, about one month after the transfusion.

In hemophilia transfusion is an effective temporary measure. It may save the patient in any particular attack but it does not alter that individual's inherited tendency to bleed.

Welch,³ Schloss and Commiskey,⁴ and others have reported excellent results with the injection of human blood serum and whole blood in hemorrhagic disease of the new-born. The value of transfusion in this condition has been conclusively proven by the clinical experience of several men.⁵ The writer has transfused nine (9) infants by means of glass tubes for this disease; six (6) of these cases have been reported.^{6, 7}

The amount of blood to be transferred to the new-born infant is very small. In my cases the duration of the flow of blood varied from three to six minutes. A baby of eight pounds is estimated to have a total blood quantity of a little more than six ounces. Since a dog cannot always survive a loss of one-half the total quantity of blood, it is fair to conclude that the loss of an exsanguinated infant is less than one-half its total quantity. The amount to be transfused to a new-born infant, therefore, is always considerably under three ounces.

Viewed from another angle these figures also show why infants seem so susceptible to hemorrhage. In dealing with these cases it is not safe to temporize too long with measures which may check the bleeding after a time but cannot relieve the anemia. This advantage of transfusion over serum injections applies with equal force to any case of hemorrhage in which we have an exsanguinated patient.

SECONDARY ANEMIA.

Transfusion is less clearly indicated in the secondary anemias which are not due to the loss of red corpuscles from the body. The cause of the anemia is too often a patho-

logical condition which is incurable or not altered by the transfusion of blood. Illustrations of the stimulating effect of transfused blood are found in its use as a preparatory measure before operations on weak patients, in pellagra⁸ and in certain cases of prolonged suppuration with profound anemia. In such instances the beneficial effect of the transfusion is obtained by increasing the patient's resistance and augmenting the natural forces which combat the progress of the disease.

In purpuric conditions of obscure etiology transfusion is not indicated by the results which have been secured up to the present time. It may prove to have a place in the treatment of the purpura when we have a better understanding of the diseases in which purpuric hemorrhages occur.

In pernicious anemia, leukemia, certain toxemias, acute infections and malignant disease the negative results are sufficiently definite to contra-indicate transfusion in these cases.

Properly safe guarded transfusion is not a dangerous operation. The withdrawal of too much blood from the donor and the dilatation of the recipient's heart are usually avoidable mishaps.

Embolism, sepsis, the transmission of disease and even hemolysis are of much less frequent occurrence than was formerly supposed. The danger of hemolysis has been exaggerated by most writers. Crile⁹ says that kinship between donor and recipient is apparently of no special advantage and the laboratory test may show hemolysis and yet the same blood be entirely safe in transfusion.

He did transfusion in eighteen tuberculosis cases and in most of these the donor's blood hemolysed the recipient's blood in the test tube but not in the patient. In spite of its comparative safety, however, transfusion should be considered a measure of last resort to be applied when simpler

means have failed and only to those cases in which there is rational basis for its use.

METHODS.

The blood is transferred from donor to recipient in transfusion by uniting their vessels either directly or at a distance. Direct union is accomplished by Carrel's suture method or by the canula method of Crile. The best means of effecting union at a distance is by means of the Brewer glass¹⁰ tubes. Clotting of the blood is prevented in the method of direct union by approximating intima to intima. In glass tubes clotting may be delayed by coating the tubes with paraffin or some similar substance.

To be successful with any method requires special training in blood vessel work. These methods have been variously modified to simplify the operation but none of the modifications have removed all the technical difficulties of a transfusion.

The method of direct suture should not be attempted without a laboratory training in blood vessel surgery. The technic is simple but difficult and the result is the same whether the vessels are united with sutures of very fine silk or by means of a canula.

The Crile canula can be successfully used by any well-trained surgeon with a little blood vessel experience. This canula has been modified by Janeway,¹³ Elsberg,¹⁴ Soresi,¹⁵ Bernheim¹⁶ and Levin.¹⁷ The instrument described by Elsberg in 1909 seems to have been most successful in overcoming certain disadvantages of the Crile canula. When using the Crile canula the vessel must be introduced through the lumen before being cuffed back over the canula. With the Elsberg canula the vessel is slipped into the canula through a slit in the side. In the original Crile instrument the cuffed vessel was secured by a ligature. The Elsberg canula has four sharp hooks, which hold the vessel in place without a ligature. Finally the Crile canula must be carried in four sizes to fit the vessels of different caliber, while

the Elsberg canula is adjustable like a monkey wrench. It can be made to fit any vessel and altered during the transfusion to increase or diminish the flow of blood. These are, on the whole, minor points but probably of sufficient importance to make the difference between success and failure in some cases.

The value of tubes in transfusion depends upon the length of time blood will flow in the tubes without clotting. Even when glass tubes are coated with paraffin or some similar substance this time is definitely limited. If this limit always exceeded forty (40) or even thirty (30) minutes this method would be practical for all transfusions because a flow of this duration is sufficient in most cases.

Fauntleroy²⁰ and Williams¹² of the United States Navy have reported several cases successfully transfused with tubes. The flow of blood was maintained thirty (30) and forty-two (42) minutes in two of the cases. Fauntleroy¹¹ used coated tubes, shaped like an "S" or "U" with a lumen one eighth of an inch in diameter. The vessels were united on the vein to vein principle. Other men have tried the tubes and reported that clotting occurred before enough blood had been transferred. I have transfused, without difficulty, eleven infants by means of glass tubes modified to suit the small, inaccessible veins of these patients and am convinced that they are of real value in these cases.

The amount of blood to be transfused in the new-born is very small, certainly less than three ounces. In my experience the duration of flow, even when the current is checked from time to time to prevent dilatation of the heart, is never more than six minutes which is well within the clotting time in these small tubes. Just how long the blood will run through the tubes I am unable to say. I have used them in transfusing a child of six years. The flow was interrupted after $9\frac{1}{2}$ minutes and at the end of the operation the blood had not clotted enough to block the tube. The tubes

made for new-born infants are 12 cm. long and 3 mm. in diameter. The end which is inserted into the infant's vein is about $2\frac{1}{2}$ mm. in diameter. They are coated with a wax mixture consisting of stearin, vaseline and paraffin in 1-2-2 proportions. The length of the tube is important because, when tied into the infant's vein, it practically lengthens this vessel to such an extent that the final connection with the donor's artery is easily made.

The connection between the circulation of donor and recipient is made by uniting artery to vein or vein to vein. Dorrance and Ginsberg¹⁸ advocate the vein to vein method to simplify the operation. Hartwell,¹⁹ Soresi¹⁵ and Fauntleroy²⁰ also speak well of this procedure. The artery to vein is the older and more widely used method. The radial artery is connected with any vein of suitable size in the arm of the recipient. In infants the arm veins are so small that most operators have taken the femoral or long saphenous vein in the thigh. I have used the external jugular vein in my last eight cases in infants and find that this vessel is well adapted to the operation in these cases.

The merit of these various methods and devices for transfusion can be summed up as follows:

Any one of them may be successfully employed, by an operator who has familiarized himself with the technic of that particular method or instrument. In other words, success in the operation of transfusion is more dependent upon adequate experience than any special method. In adults the Elsberg canula is evidently the best for the average surgeon. In infants the operation is done with the least difficulty by means of glass tubes of proper length and size.

RESULTS.

For the treatment of acute or traumatic hemorrhage in an otherwise normal individual, blood transfusion is the most effective measure at our command. When the bleed-

ing occurs in such diseases as duodenal ulcer, typhoid fever or tuberculosis of the rectum, transfusion aids mechanically in restoring the blood and may prevent a death from hemorrhage but as a therapeutic agent it seems to have no effect on the disease.

The results in shock and gas-poisoning justify its use in these cases.

In certain pathologic hemorrhages transfusion is as valuable as in acute hemorrhage. In the hemorrhages of icteric conditions the tendency to bleed can be permanently checked if the underlying disease is relieved by suitable operative measures. Hemophilic bleeding may be arrested by transfusion but the disease is not cured. In hemorrhages of the new-born, a disease which was formerly credited with a 50 to 75 per cent ^{21, 22} mortality, transfusion stops the bleeding, restores the blood and apparently transforms a very sick baby into a normal healthy infant.

Lespinasse and Fisher, in 1911, collected six cases of hemorrhagic disease treated by transfusion, with two deaths and four recoveries. In nine cases which I have transfused for this disease there have been eight recoveries and one death. Most of the patients were in poor condition at the time of the operation. The hemorrhages were usually from the bowels. In two instances large hematomas formed in the cheek. In one of the cases this was accompanied by extensive bleeding beneath the scalp. The convalescence in this case, contrary to the rule, was difficult and prolonged. The infant ran a very high temperature until the hematomas had been absorbed.

My most recent case was one of uncontrollable hemorrhage from the umbilical stump. The bleeding stopped within one-half hour after the transfusion and furnished a good illustration of the hemostatic properties of normal blood. In this case a positive Wassermann test showed that the etiologic factor may have been syphilis.

In the one case in which transfusion failed, the baby, when three days old, began passing bloody stools, apparently typical of hemorrhagic disease. Transfusion was followed by the usual improvement. Eight hours later the child vomited and began to fail. There was no sign of fresh bleeding but at the time of death, fifteen hours after transfusion, it was supposed that the hemorrhage had recurred and would be found in the stomach or bowels. Autopsy showed a diffuse peritonitis which was undoubtedly present and undetected at the time of transfusion. No perforation of stomach or intestine could be found.

The value of transfusion in secondary anemia is based upon the stimulating effect of the donor's blood. The wisdom of its use in such cases will depend upon the cause of the anemia. In general, transfusions should not be employed to restore red cells which have been destroyed within the body unless the cause of this destruction can be remedied by subsequent treatment.

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ARTICLE V.

THE TEETH AND THEIR RELATION TO
THE BODY.

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THE TEETH AND THEIR RELATION TO THE BODY.

THE title suggests a wide range in a consideration of the teeth and their relation to the human body. We shall consider only a few definite relations that are of special interest to the general practitioner, and assume that my audience is not made up of dentists but of medical men.

THE TONSILS AND OTHER GLANDS.

Fundamentally the teeth are to be considered as any other organ within the body; their anatomy, nerve and blood supply, and associated membranes are subject to the same variations from the normal (indicated in its pathology) as in any osseous or membranous tissue found elsewhere.

The teeth begin their development early in the history of fetal life — about the second month. Each tooth is evolved as a separate organ, surrounded by a membranous sac from the primitive ectodermal and mesodermal cells, which become highly specialized for the function of producing enamel, dentine and the pulp ultimately found within the tooth. The enamel comprising the crown is produced by cells differentiated for the purpose. These cells receive, through the intermediary of a dental sac (which is analogous to the placenta), all the materials necessary for the production of calcoglobulin, which later calcifies and becomes enamel prisms. Coincident with this enamel formation, other cells, — odontoblasts — produce the larger body of the tooth — the dentine. So the tooth with its membranes, as a whole, requires an organ by itself for its elaboration. And it is the

final disposition of what remains of this organ, together with such bone and connective tissue immediately outside the tooth, as well as the roots of the first temporary teeth, that are so frequently involved in tonsillar enlargements, cervical adenitis, lymphatic absorption and a variety of reflex disturbances manifested in the child and in the adult.

Five years ago we observed four distinct periods in the life of a growing child when the tonsils became enlarged coincident with the final eruption of the teeth; and at such times these tonsils, although enlarged, were in no manner diseased, inflamed or suppurative. And the significant fact remains, to date, that where these tonsils have been left alone (except in a few instances where prophylactic cleansing of the crypts has been advised), they are no longer enlarged or in any manner troublesome. These periods of tonsillar enlargement appear approximately at two years, six years, twelve years and eighteen years of age, and this coincides with the eruption of four groups of molars. We are very confident in our belief that the tonsil (which is histologically a lymphoid gland irrespective of its other possible functions) is sharing in the work of taking care of the normal physiological debris due to the elaboration and eruption of forty-eight teeth and their adjacent membranes. The faucial tonsil and normal adenoid tissue upon the side nearest to the erupting tooth may become considerably enlarged through the influence of the lymphatically absorbed waste. Nature has undoubtedly developed and placed these lymphoid organs for a useful purpose during this structural upbuilding; and it is conceivable that if we have present a number of decayed and abscessed temporary teeth, whose surrounding membranes are in close proximity to the underlying membranes of the developing permanent teeth, we shall get infection with micro-organisms and absorption of toxins through continuity of tissue, particularly so, when the temporary roots are in process of active absorption, and in consequence, we might

readily find an infection of the subjacent lymphoid glands even to the tonsil. In this latter event we may find a considerable tonsillar enlargement, and possibly a peritonsillar abscess. Under such conditions we must consider the tonsil as we would any other diseased organ requiring treatment and finally counsel its proper surgical removal if necessary.

But I do want to emphasize the fact that the tonsils are very often removed when they are merely filling the function for which they were apparently intended. In nearly 300 cases, where the tonsils were enlarged, the enlargement coincided with the second, third or fourth periods of tooth eruption. Some teeth showed that the point of the cusp had cut through the gum; others did not appear for three or four months. In no case did we find excessive enlargement of the tonsil or suppuration, but the patients were sent to us by physicians or social workers, or came on their own initiative. Another aspect of the problem is illustrated by a boy, aged eleven, who had his tonsils extirpated three years before. He came to us for treatment for glandular enlargements in the neck. The tonsillar gland was markedly enlarged and other glands were enlarged, and the trouble was distributed down to the border of the clavicle. There was no history of tuberculosis in the family. The teeth of the third period, or twelve-year molars, were in process of eruption. Another boy, aged twelve and a half, whose four molars had just erupted, had his tonsils removed; they were only slightly enlarged according to his history card. I did not see him before the operation. We were obliged to keep him in the hospital ward for four days on account of post-operative hemorrhage. A girl of seventeen had the tonsil on the right side slightly enlarged; the left tonsil was normal. The right tonsil was later removed. Three months later, the patient returned and showed an enlarged tonsillar gland the size of a hen's egg. Examination of the mouth revealed the fact that the lower third molar was cutting through the

gums — the fourth period. The remnant of a root of a lower six-year molar was also found; this was extracted, but the operation on the glands was deferred. One month later the patient reported for examination. We found the gland reduced to normal, no pain or swelling of any kind and the tooth erupted.

SUMMARY.

Tonsils are lymphoid structures.

Diseased teeth may be a source of infection and enlargement of glands and tonsils. Tonsils become enlarged without infection or disease whenever (a) the first group of temporary molars at two years of age are in process of eruption; (b) at six years when the first permanent molars and at twelve years when the second molars are active in eruption.

General practitioners of medicine, district nurses and physical examiners of school children in particular should learn at what years to expect these teeth.

Where there has been no previous history of recurrent tonsillitis and the tonsils are simply enlarged, the periodicity of the eruption of teeth should be considered.

TEETH AND DEFORMITIES OF THE NOSE AND FACE.

The superior maxillary bone is the largest bone of the face, and the most important in our problem of maxillary adjustment. It forms the roof of the mouth, enters into the formation of the floor of the orbit and, with the hollowing out of its main body, it forms the antrum. It has four processes: the nasal, malar, alveolar and palatine; and nine articulations, which means as many possibilities for maladjustment: the nasal, lacrymal, frontal, ethmoidal, malar, sphenoidal, palatal, vomer and, most important, the lower turbinal. This enumeration will indicate in part the importance of this fundamental bone, — the superior maxillary, — and what an inevitable influence it must have upon those parts immedi-



FIG. 1. Observe teeth within bony crypts, also space surrounding unerupted molar from which the membranous dental sac has been removed. (Warren Museum, Harvard Medical School.)

ately contiguous. It is not our purpose to deal with all the possible and remote influences upon these adjacent structures when expanding the arch, but we shall consider more particularly the relation of the lower turbinal to the superior maxillary, because in that turbinal we deal with the functions of respiration, ventilation and drainage, and show how the lack of these functions may be modified by the readjustment of the turbinal to its normal position through arch expansion. If you will follow with me a more detailed study of the sutures, you will readily appreciate what takes place when we readjust the superior maxillary bone and arch; for it is only with this special knowledge in mind that we can account for the marked improvement in nasal breathing that follows the proper readjustment of the teeth and maxillary bones. It will serve also to emphasize the necessity for this special knowledge by the profession at large. It is no light matter to blindly apply force to teeth in an attempt to regulate them without considering seriously the anatomical relations involved.

Let us note particularly the transverse facial suture. This connects the frontal bone with the malar, sphenoid, ethmoid, lacrymal, superior maxillary, and nasal directly across the front of the face, from the external angular process on one side, where the malar and frontal articulate, to the region opposite. Let us consider briefly the structure of these sutures. Where the adjacent margins of bones are in close contact, we find a thin layer of fibrous membrane, called a sutural ligament between the bones. In some places a thin layer of cartilage is interposed instead. When ossified it is no longer a true suture, although its former outline may be defined. Unossified, the suture has between its parts a fibrous connective tissue, capable of being stretched, with regenerated growth, and subsequent ossification. And because this is so, the orthodontist is capable of assisting nature in the normal lines of growth, thereby

obtaining such remarkable results as are shown in the enlarged arch.

Incisive or premaxillary sutures in the young are seen sometimes up to the age of six years, that is, the intermembranous tissue laterally does not ossify until then, although it may remain free in the median line for some years later. We can appreciate the ease with which these sutures may be opened in the young developing body and the consequent care and intelligent application of force that must be applied in order not to outrun nature in the extent of space to be gained, or to apply force when the organism, as a whole, is not active in development. We must also bear in mind that under the influence of the stimulation of expanding the arch within normal physiological limits, we obtain in addition to sutural growth some interstitial growth in the alveolar process between the teeth. And ultimately, what surer guidance can we have than being led by what we know, to date, of the normal adjustment in lines of growth of the teeth and normal occlusion. If we bring those units into harmony, provide for their continuance through normal interlocking and daily use through mastication, nature will take care of the adjacent superstructure and subsequent ossification of the sutures as the only permanent retainer. The structural growth of a face may be developed along normal lines in its lateral halves, and the middle third of the face exhibit only a partial development. To be more explicit: the lateral halves refer to the superior maxillary bones. The middle third includes the premaxillary bone, which may be considered part of a central mass and contains the structures of the middle third of the face, as the cartilaginous triangle of the nasal septum, the ethmoid plate and the nasal bones up to their articulation with the frontal. When we find this lack of development in the middle third in the adult, it bears the same relation in its extent of growth to that of the child, clearly indicating the arrested development. The incisors in such a premaxillary

bone do not of necessity share in this lack of growth, but appear to develop as an independent center. From the foregoing statement it is obvious that any attempt to reconstruct this middle structural mass through application of orthodontic apparatus would be ill-advised. The arbitrary application of mechanical force to the teeth must be made with reference to changes which ultimately occur in the structures beyond the teeth. Whenever this is done without such consideration, new and complicated malformations may be induced and become evil in effect. We may, however, arrest further tendency to malformations and assist by giving direction for true lines of growth until such time as the organization, as a whole, shall become active in further development.

Ballenger in an article entitled, "The Vicious Circle of the Nose," states the following well-known law, — "Any cavity lined with mucous membrane is predisposed to infection and inflammation when its drainage and ventilation is impaired." This law obviously includes any condition, whether anatomical or pathological, causing obstruction to the normal flow of the secretions. Furthermore, it is equally apparent that if the obstruction to drainage and ventilation is removed, the predisposition to infection and inflammation will also disappear. We have frequently found this cavity of the nose constricted, its ventilation and drainage impaired, at the same time that we have found a corresponding deformity within the oral cavity with its narrowed, contracted and high arch, and malposition of the teeth. We know too well what the picture of the vicious circle of the oral cavity is: imperfect alignment of the teeth with attendant ugliness, loss of mastication, caries, disease, crowding of the tongue, and unsanitary condition of the whole. We shall add the further observation that whenever we find the teeth out of harmony with each other and the malocclusion has been maintained for some time, we shall invariably find from

one to four deformities of the nose that are coincident with the dental abnormality. We must not be understood as implying in this statement that all nasal obstructions and deformities have a dental origin; many of them are due to other factors than the teeth. For example, there are certain pathological conditions that are immediately responsible, also factors of inheritance, lack of development of the parts or overdevelopment. Traumatism is also responsible sometimes for nasal obstructions, also unstable nervous adjustment, etc. Having ruled out these possibilities we find first one or both sides of the nares collapsed when the premaxillary portion of the superior maxillary bones and its contained incisors are not in proper position or development. This collapse of the nares means that the supports for the cartilage and the musculature of the nose are not in tone and do not function. Secondly, a contracted maxillary arch places the lower turbinals either too near the floor of the nose or too near the septum. This is more particularly in evidence when the bicuspid and first molars are maloccluded. Thirdly, an extended contraction of the maxillary arch, where the roof approximates the Gothic type, induces a marked thickening along the groove which contains the base of the septum and vomer.

In endeavoring to restore function to the superior maxillary bone through the normal adjustment of the parts, it is important to note its histological structure. The lining membrane of the outer vestibule of the nose is practically continuous with the skin; here we find a stratified epithelium through which pass the hairs called vibrissæ. Entering the nasal cavity beyond the nares we find it lined with a mucous membrane; here we find a ciliated epithelium extending along the floor and side walls of the nose (the antral walls) back to the nasopharynx. Beneath the ciliated cells and membrane of the floor of the nose are numerous lymphatic glands. So the respiratory region proper is considered as



FIG. 2. Author's instrument for measuring internasal breathing space before and after readjustment of the maxillary arch.

along this tract, extending upward to the superior border of the lower turbinal, including actively the middle meatus, where we begin to exercise our olfactory sense. It must be borne in mind that the entire group of sinuses of the head — *i.e.*, the antral, frontal, ethmoidal and sphenoidal sinuses — take part in respiration. The lower meatus (the antral wall below the lower turbinal) is a region of the utmost importance in our study. The lining membrane covering the bony wall in this region is composed of a very thin tunica propria, whose epithelium is exceedingly attenuated; the glands are small and few in number. We have selected this particular region for our comparative measurements because it offers the nearest points of contact with the bones of the wall of the superior maxilla in our process of expansion and readjustment. Furthermore, the lower turbinal is attached to this same antral wall, and must, of necessity, share in the readjustment.

With this detailed statement in mind we are in a position to judge of the relative merits and importance of measurements which shall be made within the nose in conjunction with readjustment of the maxillary bone. Obviously the rapidly and highly fluctuating and irregular turbinals are unfit for our purpose, and only a region which actually moves outward in the process of arch expansion, and where the character of the membrane is thin and near the bone and free from variations in the healthy state, is at all reliable and worthy of consideration. We have found that region to be in the lower meatus below the turbinal already described.

I have here an instrument through the use of which I can get three measurements: horizontal, lateral and vertical, and there are scales on which each of these measurements are recorded. To prepare the region of the lower meatus for the introduction of finders on the measuring instrument, we introduce into each nostril a piece of gauze saturated in a 4 per cent cocain and 1 : 1000 adrenalin solution. After five

minutes the gauze is removed, and the lower turbinals are examined, distending the nares with a Myles speculum. An applicator is passed under the lower turbinate body until the lower meatus is found. If this is difficult because the lower turbinal is too closely approximated to the antral wall, a flexible finder of a predetermined length is fitted into the measuring instrument. We are then ready to record the first measurement before any expansion apparatus has been applied for readjusting the maxillary arch. The patient holds the horizontal standard lightly between the teeth to help in steadying the instrument. This in no way affects the accuracy of the measurements because the outside measurements of the length of the face control that. The measurement is to be only comparative for the individual. A point is found between the central incisors at the gingival margin, another on the frontal bone between the frontal sinuses and the facial length is recorded. The finders for the antral wall are next introduced, their depth within the nose anteroposteriorly is recorded, as well as the greatest horizontal width for that depth, and the angle of inclination of the finders, which is shown marked off in degrees on a quadrant. These records are made for depths of one or two centimeters within the nose, or any part thereof. Experience, however, has demonstrated that the greatest deformities exist in the region of the anterior third of the lower turbinals and lower meatus. The finders on the measuring instrument are quickly removed and sterilized, and the whole instrument is easily cleaned.

A description of a few of the many practical cases which we have examined, measured and corrected, and finally examined and measured again, will indicate without too much repetition the value of this work and will suggest incidentally a wider field for future study.

The first case I will mention is that of a boy of twelve years. The anterior upper incisors were in malocclusion;

the laterals in lingual occlusion to lower teeth and irrevocably locked inside the arch. The premaxillary bone was small but the teeth in it were well developed. Both anterior nares were collapsed and acted as valves with each inspiration of air. The upper arch was contracted in the region of the bicuspid. The internal nose showed approximation of the lower turbinals to the septum, which deviated slightly above and below, making a double curve. There were no spurs or thickenings, or otherwise marked diseased conditions of the mucous membrane, except a slight redness and swelling. The boy could not breathe freely through the nose; his general condition was poor, his color anemic and he altogether lacked stamina; he was subject to frequent nasal colds. The distance between the antral walls below the lower turbinals before regulating the teeth was 10 mm., and after regulating 16 mm.; between the first bicuspid before regulating the distance was 23 mm.; after regulating 33 mm. After readjustment and obtaining good occlusion, the nose showed the nares in good tone as compared with the former collapsed condition; the deviations of the septum were gone; and the turbinals were in relatively good position away from the septum and slightly raised from the floor of the nose, and there was no difficulty in nasal respiration.

The second case is that of a man of twenty-seven years. This patient presented a long and narrow face, a high, contracted and V-shaped arch, and teeth in badly decayed condition. He was a mouth-breather and subject to head colds, and was below the normal in weight. The insurance companies had refused him insurance, considering him a bad risk. He was sent to me by a rhinologist, who stated that he hesitated to operate on the lower turbinals where the dental deformity was so marked. For a period of three months we stretched the maxillary sutures; at the end of this time the incisors had moved apart, and the patient reported freedom in nasal breathing. It took fifteen months

more to adjust his teeth, during which time the patient's health improved in every way. The measurements between the antral walls before adjustment were $8\frac{1}{2}$ mm., after adjustment, 15 mm.

Another case is that of a girl of eleven years. The abnormality of the teeth was not serious; there was a slight contraction in the region of the bicuspid; the arch was tending to the Gothic type. The turbinals on both sides were near the floor of the nose; breathing was more or less interfered with and the patient was subject to nasal and head colds. We were impressed with the idea that with a little attention to tooth regulation, by simply keeping the patient under observation and gently applying force in maxillary expansion to lead the arch out to normal, nature would complete the growth and soon establish normal conditions within the mouth as well as in the nose. The measurements within the nose before treatment showed 12 mm., after treatment $14\frac{1}{2}$ mm. The turbinals were lifted from the floor of the nose, the floor assumed a declination of two degrees and good nasal breathing space was established.

In all the cases we might cite the significant facts are these: All show some nasal deformity coincident with a dental irregularity. They all show a change in the width between the superior maxillary bones, measured between the antral walls below the turbinates, as recorded before and after regulation respectively. They all show improvement, some slight and others to a marked degree, in intranasal respiration after maxillary readjustment, and in consequence the patients enjoy a better nasal sanitation, ventilation and drainage, better nasal respiration, and greater freedom from head colds. The factor of restored facial symmetry must not be lost sight of, although, personally, I am more inclined to feel that, after the normal function of the mouth and nose has been restored, all other beauty and harmony will inevitably follow.

ARTICLE VI.

THE EFFECT OF THE PASTEURIZATION
OF MILK ON BABIES.

By JOHN LOVETT MORSE, A.M., M.D.,
OF BOSTON.

DELIVERED JUNE 12, 1912.

THE EFFECT OF THE PASTEURIZATION OF MILK ON BABIES.

THERE is no doubt that the pasteurization of milk at as low a temperature as 140° F. for as short a time as twenty minutes destroys pathogenic organisms and that higher temperatures for a shorter time will do the same. There can be no question, therefore, that the pasteurization of milk diminishes the danger of infection with these organisms and the incidence of the diarrheal diseases, in so far as they are caused by bacteria. It seems probable, from the work done recently at the United States Agricultural Experiment Station, that the belief that the bacterial flora of pasteurized milk is different from and more dangerous than that of raw milk is erroneous. It was found there that the relative proportions of acid-forming, liquefying and inert bacteria were essentially the same in efficiently pasteurized milk as in clean, raw milk. Their work also showed that the rate of multiplication of bacteria is the same in pasteurized as in raw milk.

It has been claimed that the pasteurization of milk destroys the vital properties or the "life" of the milk, thus rendering it less suitable as a food for infants. These vital properties are presumably represented by the enzymes or ferments of the milk. There is no question that the digestion and metabolism of cows' milk by the infant is carried on by ferments. There is also no question that the infant itself provides ferments to do this work. There is no evidence to show whether the infant's ferments are intended to do the whole of this work or whether the ferments in the

milk are intended to do a part of it. It is impossible to know, therefore, whether the destruction of the ferments in the milk will do harm or not. As a matter of fact they are not only not destroyed, but, as a rule, but little weakened by pasteurization at low temperatures.

The power of cows' milk to produce a specific lactoserum is not affected by heating for one hour at 248° F. Pasteurization for one-half hour from 140° F. to 149° F. weakens, but does not destroy, its bactericidal action. The oxidizing ferment of 'cows' milk is unchanged by heating at from 140° F. to 149° F. for one hour, but is destroyed by short heating at 168° F. The proteolytic ferment is unchanged by heating for one hour at 140° F. or one-half hour at 149° F. The alexins are still active, although weakened, after an exposure of one-half hour to a temperature of 149° F.

It is, or has been, very generally believed by physicians in this country that the heating of milk makes it less digestible by infants, that infants fed continuously on heated milk do not thrive as well as those fed on raw milk and that the continuous use of heated milk predisposes to the development of the diseases of nutrition; scurvy, rickets and anemia. What is the evidence for and against this belief?

The evidence derived from laboratory experimentation as to the relative digestibility of sterilized, boiled and raw milk is inconclusive. There is very little as to that of pasteurized and raw milk. The heating of milk at temperatures under 150° F. has no effect on the rising of the cream. Heating milk at 150° F. or over for one-half hour delays or prevents it. The fat droplets in raw milk agglutinate into tiny globules or masses, while in milk heated at 150° F. or over these clusters are broken down and the globules are more homogenously distributed throughout the fluid. The heating of milk at 140° F. for twenty minutes has no effect on the coagulation by rennin. When milk is heated at 176° F. or over, however, the coagulation of the casein by

rennin is delayed and the curd is less tough and more flocculent than in raw milk. The lactalbumen is denatured by temperatures between 167° F. and 176° F. What little laboratory evidence there is shows, therefore, that the pasteurization of cows' milk at low temperatures has no effect on its digestibility, while the pasteurization at slightly higher temperatures apparently makes it more, rather than less, digestible.

The results of animal experimentation are contradictory, unsatisfactory and inconclusive. Dean, for example, got larger gains when he fed calves with pasteurized milk than when he gave them raw milk, while Doane and Price conclude from their experiments with calves that raw milk is more easily digested than either pasteurized or cooked milk, and Raudnitz, working with dogs, found that raw milk was utilized better than sterilized milk.

Very few metabolism experiments as to the relative utilization of the various elements in raw and heated milk have been carried out in infants and in the great majority of these experiments the milk has been sterilized instead of pasteurized. The results of these experiments are so contradictory that little reliance can be placed upon them. It seems probable, however, that there is but little difference in the utilization of raw and pasteurized milk.

Those who believe that infants thrive as well on heated as on raw milk and that heated milk does not predispose to the development of the diseases of nutrition advance in favor of their belief the fact that babies in France and Germany are almost invariably fed upon heated milk. Variot, for example, during the twelve years subsequent to 1892, distributed 400,000 bottles of milk sterilized at 108° C. to more than three thousand infants, and found that only 3 per cent or 4 per cent of them were incapable of using sterilized milk and that rickets did not develop in any. Constipation and anemia were, however, not uncommon. His

statement that rickets did not develop in any is, however, open to doubt, because, if the babies in France are like the babies in America, at least 80 per cent of all the babies of the hospital class show signs of rickets. This fact raises a certain amount of doubt as to the accuracy of his observations in other respects. He says nothing as to whether any of them developed scurvy. Carel fed 210 babies on ordinary milk and 373 on sterilized milk, the babies belonging to the working class in Paris. He states that 31.8 per cent of the babies fed on the ordinary milk showed evidences of rickets and only 15 per cent of those fed on the sterilized milk, while none of them showed signs of scurvy. The same criticism as to the frequency of rickets in this country and in Paris applies to his figures as to those of Variot. It must be remembered that at this time the French physicians were not familiar with the symptomatology of scurvy and that very few cases had been reported by them. Since they have learned to recognize the disease many more cases have been reported and it is evident that the disease is far more common in France than was formerly supposed. Finkelstein found that babies fed with cooked woman's milk did not do as well as those fed with raw woman's milk. He then fed a series of babies on cooked milk and raw milk, the modifications being the same, and found by a study of parallel cases no essential differences in the development and condition of the babies. He also states that similar experiments made in Stockholm, during a period of three years, failed to show any differences in the development of the babies fed on cooked and raw milk. There have been, as far as I know, no comparative studies of large series of babies fed on pasteurized and raw milk made in this country. It must be admitted that the evidence advanced to show that the heating of milk is harmless is very strong. It is evident, on the other hand that it is not as strong as it at first appears.

Some of those who believe in the innocuousness of the

pasteurization of milk for infants claim that it cannot cause rickets, because rickets is not due to improper food but to improper hygienic surroundings. While improper hygienic surroundings almost certainly play a part in the production of rickets, it is equally certain that improper food and hereditary predisposition also have a share in its etiology. The relative importance of the different factors is, however, at present unknown. In fact, the exact etiology of rickets is extremely obscure. Such being the case arguments as to the effect of the pasteurization of milk on the development of rickets are practically valueless.

All large series of cases of scurvy show that a considerable proportion of the patients were fed on heated milk, more of them, however, on sterilized, boiled or scalded than on pasteurized. It has been believed by many, therefore, that the heating of milk is the most important single factor in the etiology of scurvy. Others claim that it was not the heating of the food which caused the scurvy in these babies, but the composition of the food which was heated. They advance in favor of their claim that scurvy also sometimes develops in the breast-fed and not infrequently in babies fed on raw milk. It is evident that when an individual baby is fed on a heated, modified milk it is impossible to know, if scurvy develops, whether it is due in the special case to the heating or to the composition of the milk. It can only be a matter of opinion. A decision can only be made by the analysis of large series of cases. How unsatisfactory this method may be can be judged from the fact that the results of the analysis of the series collected by the American Pediatric Society, the largest single series on record, are quoted by different writers as proof of both sides of the question.

The evidence from the literature as to the effect of the pasteurization of milk on its digestibility by infants and on their nutrition being so unsatisfactory, it seemed to the writer that it would be well worth while to find out what

was the opinion of the leading pediatricians in this country as to these points, especially as the objections to the heating of milk to be used as a food for infants had been raised almost entirely in this country. A circular letter was therefore sent to the members of the American Pediatric Society asking the following questions:

1. Is pasteurized milk more or less digestible than unpasteurized milk?

2. Do babies that are fed continuously on pasteurized milk thrive as well as those that are fed on unpasteurized milk?

3. Does the continuous use of pasteurized milk predispose to the development of the diseases of nutrition?

Scurvy?

Rickets?

Malnutrition?

Anemia?

Replies were received from fifty. No one of them had made a careful, statistical, comparative study of the subject. Many of them called especial attention to the fact that they were merely expressing their opinions or their impressions. Some had positive opinions about one point, others about another; one man thought, for example, that pasteurization predisposed to scurvy and not to rickets and anemia, another that it predisposed to rickets and anemia and had nothing to do with scurvy, another that it predisposed to rickets alone, and so on. A number who thought that the pasteurization of milk did not make it less digestible or predispose to the development of the diseases of nutrition stated, however, that they prescribed raw milk, if possible, while others stated that they always gave fruit juices when they used pasteurized milk continuously, making it appear as if they were not quite sure of their ground.

Eight of the forty-two who answered definitely the question as to the comparative digestibility of pasteurized and

unpasteurized milk think that pasteurized milk is more digestible than raw milk, twelve that it is less digestible and twenty-one that pasteurization makes no difference in its digestibility.

Forty-two gave definite answers to the second question as to whether babies thrive as well on pasteurized as on unpasteurized milk; nineteen think that they do and twenty-three that they do not.

Eighteen of the thirty-eight who answered clearly the question as to whether the continuous use of pasteurized milk predisposes to the development of the diseases of nutrition believe that it does and twenty that it does not. Eighteen of thirty-seven think that it predisposes to the development of scurvy, twelve of thirty-four to that of rickets, seventeen of thirty-seven to malnutrition and anemia.

It is evident, therefore, that there is no unanimity of opinion among the leading pediatricists of this country as to the effect of the pasteurization of milk on its digestibility and as to whether it renders it less suitable for the feeding of infants. The difference in their opinions being so great, it is, of course, impossible to draw any definite conclusions from them.

The only conclusions which seem to me warranted from my study of the subject are as follows:

It is impossible to determine from the evidence at present available whether or not babies fed continuously on pasteurized milk thrive as well as those fed on raw milk or whether or not the continuous use of pasteurized milk predisposes to the development of the diseases of nutrition. There is sufficient evidence to show, however, that if the continuous use of pasteurized milk is injurious to babies, its possibilities for harm are much less than those of bacteria. All but the cleanest milk should, therefore, be pasteurized before it is given to infants. There is, on the other hand,

sufficient doubt as to the innocuousness of pasteurized milk to justify the avoidance of pasteurization whenever the character of the milk warrants it. Finally, our knowledge of the whole matter is extremely incomplete and unsatisfactory. The question as to the effect of the pasteurization of milk on the nutrition of infants can only be settled by a much more careful and extensive study of the whole subject, both in the laboratory and clinically, than has hitherto been undertaken.

ARTICLE VII.

THE PRESENT STATUS OF SALVARSAN.

BY ABNER POST, M.D.
OF BOSTON.

DELIVERED JUNE 12, 1912.

THE PRESENT STATUS OF SALVARSAN.

WHEN one speaks of the present status it allows the inference that there has been a change in opinion and that there will be further change in the future. It is true that Salvarsan is not quite the wonderful drug that we were led to expect. It does not cure syphilis by a single massive dose.

It is also true that the repetition of the dose does not make a dangerous race of spirochætæ and a worse form of disease.

But the tales first told of 606, that it causes symptoms to disappear in an incredibly short space of time, are true. It acts with incredible rapidity on the moist lesions of syphilis — those which are particularly liable to transmit the disease. Many of the early accounts of the drug were illustrated by photographs of various lesions taken before and after the administration of the drug. Pictures could still be taken which show a striking improvement after the drug, but unfortunately all these patients do not stay cured.

Salvarsan heals cases which mercury has failed to cure, but not all of these stay healed. These cases comprise the early malignant cases, in which the lesions have a tertiary character in the time appropriate for early secondary symptoms.

With the recognition that a single dose does not always cure and that repeated doses may be given has come the tendency toward smaller repeated doses rather than one massive dose.

At first Salvarsan was given subcutaneously. This was soon changed to an intramuscular injection. This proved

a very painful method like the first, and required usually the administration of morphine to render the pain endurable. Moreover, the drug was not always absorbed but remained encysted for weeks and months. Sometimes it acted as an actual escharotic and a chemical slough resulted which separated very slowly and which it was necessary sometimes to dissect out before healing took place. The administration by intravenous injection of a more dilute solution was then advised and that method is the one now generally, but not universally, used. The yellow powder is first dissolved in 100 c.c. of sterile water or normal salt solution — it is then precipitated by the addition of a solution of sodium hydrate which is still further added drop by drop until a clear alkaline solution is formed. To this solution is still further added 200 c.c. of salt solution and after filtering the clear yellow liquid of 300 c.c. is ready for use. All the utensils used should be sterilized. The same aseptic precautions should be carried out as for any serious operation. The solution should be neutral or faintly alkaline. A hospital operating room is the proper place for its administration though it may of course be given at a private house just as any operation may be done in a private house, —and I cannot say that a doctor's office is a proper place for its ordinary administration.

The administration is likely to be followed by unpleasant symptoms — a rise of one to five degrees in temperature, a decided chill, vomiting and diarrhea may or may not follow. It has been found that these symptoms are less likely to follow if the water used has been freshly sterilized. This precaution certainly has some effect in diminishing the unpleasant after effects but the size of the dose is also to be taken into account.

These immediate effects are transient, usually they are over after four to six hours, but occasionally a diarrhea persists for a few days. These effects are by no means

universal. A very large proportion of patients escape them entirely, but very occasionally they are severe — sufficiently severe to demonstrate the fact that one is dealing with a powerful drug which must not be administered rashly or without discrimination. It was at first advised to retain patients in hospital or in bed for several days. A few hours are now considered sufficient.

But there are more serious allegations against the drug than mere transient discomfort. A certain small number of deaths have been reported. Most of these deaths have occurred in cases in which the drug was given as a last resort, where the patients would have died without the drug and may be said to have actually died in spite of its use. But there have also occurred a few cases of hemorrhagic encephalitis in which the drug seems to have been the lethal agent. Three cases of this character are reported in one of the more recent books dealing with 606 and four more were reported, or rather mentioned, at the recent meeting of the American Medical Association at Atlantic City. Few as these cases are they are sufficient to cause a certain hesitation in rash use of the remedy.

Browning and Mackenzie, joint authors of a valuable book on Salvarsan published late in 1911, believed these cases to occur once in 40,000 administrations.

They also mention that similar cases have occurred in syphilitics who were taking mercury, and that the mercury was believed to be a causative agent.

These cases give additional weight to the charge that Salvarsan causes other changes in the nervous system. The chief accusation concerns its action on the auditory nerve. It is said that as atoxyl attacks the optic nerve, so Salvarsan shows an evil affinity for this nerve.

It is true that various individuals have had attacks of deafness attended by facial paralysis, vertigo, staggering gait and vomiting but these cases differ in nothing from

similar attacks in syphilitics recorded before Salvarsan was invented. Dr. E. A. Crockett of this city reported cases of that character. He mentioned that he had seen twenty or twenty-five cases during the previous year since they had been called to his attention.

Two of the cases reported with some detail were of special interest in this connection. One was attacked with deafness, dizziness, and staggering gait about six months after the contraction of his disease. During that time he had been under treatment by mercury and iodides and was still under such treatment.

The other case had the same symptoms — had suffered with the disease about the same length of time but had received absolutely no treatment whatever. These cases occurring before 606 correspond exactly with the cases of deafness which occur after 606.

Other cases of the same character were reported by many aurists and syphilographers before 606 was invented. These cases are thus syphilitic in character, and since the present discussion as to the value and danger of 606 they have been termed neuro-recurrences or neuro-recidives. I shall refer later to a case of this character. But while their syphilitic character is recognized, their possible relation to 606 remains to be determined. Finger claims to have seen twice as many affections of this character since 606 as before, and in consequence he has abandoned its use.

Personally I cannot help feeling that the new interest felt in syphilis must have something to do with the recognition of this aspect of the disease, that cases that would previously have not been reported have of late been brought to public attention.

These cases simply show that 606 fails to reach all the spirochætæ in the body. These cases improve under a repetition of the drug or other antisyphilitic treatment, though unfortunately some degree of deafness persists in some cases.

The best argument for the curative effects of the drug is found in the reinfections which have taken place after its use. There are several such cases reported. The immunity of syphilitics against further infection is evidently due to the fact that the syphilis still remains present and the renewed inoculations show that they have been freed from its continuance. If such reinfections should be finally confirmed it would settle the value of 606. It would show that we really have it in our power to cure the disease.

In primary syphilis 606 removes the original lesion with wonderful rapidity. Mercury also heals the primary sore. The chancre is also healed without remedies but by 606 it is rendered sterile within 24 hours. It is entirely healed much more quickly than by mercury and the constitutional symptoms have failed to appear up to the present time in a large number of cases. We have every reason to believe that 606 given before secondary symptoms or just as they appear and followed by mercury actually cures the disease. This clinical observation is confirmed by blood examination.

Certain personal experiences deserve mention. It has been my opportunity to treat in this way during the past year four physicians with primary syphilis of the hand, received in the practice of their profession. All have recovered, to all appearance, without constitutional symptoms. It is no small privilege to retain in active practice men who otherwise must have remained inactive for a series of months at least. These cases ought to rank high in our estimate of the value of Salvarsan.

Certain chancres of the lip ought to be mentioned. One was a little girl of 13 who appeared at the Boston Dispensary several weeks ago. She had upon the upper lip a sore which was clinically a chancre. Spirochætæ were found and Salvarsan was administered at that first visit. The sore itself has entirely healed and no later symptoms have

yet appeared although the time is long past for their appearing. We hope that she, also, is cured.

It may be considered irrelevant but I cannot avoid speaking here of the work of the Social Service of the Boston Dispensary in this case. It was naturally a matter of interest to know the source of this little girl's infection and she was called upon later at her address by our social worker who found a syphilitic baby in the family where she was visiting and brought the baby and its relatives under medical care.

In the same way a young woman with a chancre of the lip who was the sole support of a family of five was quickly restored to work before the family became public charges. Two or three domestics have similarly been helped and we believe cured, though we recognize that time alone can determine.

In secondary syphilis the moist lesions, mucous patches and ulcerated papules are rendered harmless almost immediately.

Various patients especially worthy of mention have come under observation.

A mother accidentally infected, communicated the disease to the father. Both father and mother showed abundant mucous patches. Their little girl of six was so far unharmed. 606 healed the dangerous moist lesions in the parents and removed the danger from the child.

In late destructive or tertiary lesions 606 shows the same ability to act more quickly than mercury. We all know how valuable potassic iodide is in such cases.

Some of these late cases have continued in a more or less active condition for years. Some are simply recurrences after years of quiescence. All show the persistence of the disease and most of them its persistence in spite of treatment. One who uses Salvarsan at all naturally feels a desire to give the patient the opportunity to recover if possible under its use.

The following case is worthy of report here.

A man presented himself recently at the Boston Dispensary with deafness and ringing in the ear, intolerable pain in the head, facial paralysis and unsteady gait. He had been a patient at that institution thirteen years and shows to-day numerous scars of an early malignant case. He has had no treatment since that time. Potassium iodide and mercury caused a very rapid improvement in his symptoms but he still complained of intolerable pain. He was then given Salvarsan with rapid relief.

The benefit from 606 in this case was very marked. It is possible that the same benefit would have finally followed the iodides and mercury but after Salvarsan it was immediate. The case is most valuable as showing the effects of the disease by the same group of symptoms which sometimes follow the administration of 606.

The lesions of the nervous system which represent actual destruction of the parts affected are no more healed by Salvarsan than by any other drug. It is a great disappointment to be obliged to recognize that tabes or general paralysis are little if any more under our control since the advent of Salvarsan than before. It may be said for Salvarsan that the pains of tabes are diminished by 606. The nervous lesions which we are accustomed to treat by potassic iodide are also helped by Salvarsan. Salvarsan is probably a little better of the two drugs.

It has been already mentioned that Salvarsan renders syphilitics much less dangerous to the community. This puts into the hands of health authorities an instrument of the greatest value, which has not yet been used as freely as might be. One of the difficulties in the control of syphilis has been the very long time during which it was necessary to detain patients in hospitals and almshouses. The rapid action of Salvarsan does away with that serious objection.

It was early recognized that Professor Ehrlich would not remain satisfied but would continue his studies and a Neo-salvarsan, numbered 914 is now the subject of clinical investigation. It is more easily manipulated, is less irritating as an intramuscular injection and may be repeated indefinitely. Its virtues are not finally settled and it has not yet been put upon the market.

SUMMARY.

The present status of Salvarsan may be summarized as follows:

It is the most rapid and powerful antisymphilitic known.

It is not without its dangers which are sufficient to induce caution in its use but not its abandonment.

It is not yet possible to promise an absolute cure.

One should not urge its use upon those who are impressed by its possible ill effects.

It should be used in conjunction with mercury in all cases in which a diagnosis can be made before general symptoms appear.

It should be used in all cases in which patients are not progressing well under ordinary treatment in any stage.

It should be used in all cases in which patients are an especial danger to the community.

It should not be used in maximum doses but rather in repeated medium doses and in exceptional cases in repeated minimum doses.

So used it is one of the most wonderful drugs ever conferred upon humanity.

ARTICLE VIII.

MEDICAL ASPECTS OF INTESTINAL
ADHESIONS AND PTOSES.

BY JAMES MARSH JACKSON, M.D.
OF BOSTON.

DELIVERED JUNE 11, 1912.

MEDICAL ASPECTS OF INTESTINAL ADHESIONS AND PTOSES.

IN discussing the subject of adhesions, so far as they affect the intestinal tract, I can mention in the short time at my disposal only the most important points as they have presented themselves to me after a long and careful study of the subject both clinically and surgically; and one cannot discuss adhesions without also mentioning ptoses of the colon, for the one rarely occurs without the other.

In regard to the cause of the adhesions, most of my cases have been due to old appendicitis and peritonitis. In many of these cases there was no knowledge on the part of the patient of ever having had peritonitis, and yet, at operation, it was definitely shown that the original source of trouble was, without doubt, the appendix. In one case the peritonitis occurred at 13 years of age, but no symptoms of any trouble from adhesions appeared until after 60. This long lapse of time between cause and result is a very important point, and has obtained in a considerable number of my cases.

Adhesions may be in the form of a membrane cementing, or rather binding, the coils of intestine together and to other organs, or to the abdominal wall, or they may occur as bands, which may in time (possibly many years) cause kinks, as described by Lane, or partial or total obstruction.

Now what are we to look for as our guide posts in such cases?

First is chronic constipation. This is relieved to some extent by diet, but we find drugs very necessary if regularity

is to be established. The intestines have to be forced to do extra work in order to overcome the extra resistance which becomes more and more marked as time goes on, until we reach a time when the bowel tires out, and then comes atony, or rather a debility, of the bowel and the case becomes extremely obstinate. We must then resort to operation, and when this time comes we find an extensive freeing of the adhesions is necessary.

This explains many cases of chronic constipation and consequent toxemia from absorption, as evidenced by frequent attacks of migraine and sick headache which we attribute to "torpid liver," hereditary sluggishness of the bowels and other such evasive diagnoses.

And now comes the most important part of my talk and the part that I wish to lay particular stress upon, namely, colitis, as an important symptom of adhesions. From my studies of the last three years I am ready to say that I do not believe there is any such thing as hysterical colitis. This may seem very radical, but in my last twenty-five cases of colitis which have been diagnosed as nervous or hysterical by competent observers, the true cause was found to be adhesions.

Case 10. — A woman of 40 who had always been well and strong, except for puerperal fever when 30 years old, became involved in a very disagreeable law suit. Within a short time she began to complain of severe abdominal pains coming in attacks every few days. The pain usually lasted for several hours and ended with the discharge of clear mucus. This condition persisted for about six months and practically disappeared with the clearing up of her domestic troubles.

Several months later she began to have a feeling of general discomfort in the abdomen, and a tendency to constipation. Mucus appeared again in the movements, stringy in character, and occasionally in the form of a cast. In spite of all treatment she grew gradually worse until finally operation became necessary. A large number of adhesions

were found, especially in the region of the cecum and transverse colon.

Since the operation, conditions have been much improved, but the colon has never entirely regained its tone. The nervous strain under which she labored at first undoubtedly had a great deal of influence in bringing on her colitis, but my contention is, that this would never have occurred had it not been for the partial obstruction of the bowel due to adhesions.

This is only one example of many, and I beg all of you to consider this before you make your next diagnosis of hysterical colitis. The textbooks have called this ailment "mucous colic," "membranous" or "mucous diarrhea," "nervous colitis," and by many other names, and have advised alkaline laxatives, olive oil, diets ranging from nothing but hot milk to bran bread and coarse vegetables, massage, irrigations and innumerable other things. In a certain number of cases these methods of treatment have been successful, but in a great many instances the trouble is due to definite pathological conditions of the intestine causing various degrees of obstruction, and it is to these cases that I wish to call your attention particularly, since by definite surgical measures the trouble can be corrected.

Diarrhea has been subdivided into various groups, but clinically the fine distinctions of duodenitis, jejunitis, ileitis, colitis and proctitis cannot always be made, and we must be content with a division into catarrh of the large and catarrh of the small intestine. Naturally, these two conditions often coexist, but one will usually predominate, and it is the involvement of the large intestine that I shall consider especially.

We may pass over in a few words the various theories of the etiology of mucous colitis. Nothnagel held from the beginning that it was a secretory neurosis without local lesions, and that it was dependent on a neurasthenic condition of the patient, and many have shared his opinion.

On the other hand good observers hold that the condition is a primary disease with definite lesions in or around the colon. Furthermore, if the former assumption were true we should expect to find many cases among persons afflicted with nervous disorders, but my inquiries at several hospitals for the insane have proved that this is not the case.

From personal observation I can say that one meets many difficulties in coming to a conclusion. My experience leads me to believe that while there can be no doubt that periodical membranous dejections are frequently observed in neurasthenic and hysterical women, yet — and this is the distinguishing characteristic — they scarcely ever occur without simultaneous habitual constipation. When the constipation is well marked, mucous colitis occurs, and it ceases only when the constipation is corrected.

With the greater attention now being devoted to this condition, and the improved methods of diagnosis, such as the x-ray used after ingestion or rectal injection of bismuth, and the scholarly researches of Cannon on intestinal action, we have recently learned a great many new facts regarding the bowels. With this valuable information at our disposal we are now able to understand and therefore to cure cases that a few years ago we should have been obliged to go at blindly. Now we are often able to recognize, and by surgery to relieve, anatomical abnormalities, either congenital or acquired, which are causing the trouble.

Mucous colitis is seen most commonly in women between the ages of 25 and 40, though it is by no means confined to that sex or to those age limits. As may be judged from its name, the most characteristic symptom is the presence in the stools of mucus in varying amounts. The mucus may be thin and glairy, or of a heavier consistency and nearly white, and may even closely simulate a membrane whence the name "membranous colitis" that is so often heard. At the

same time, chronic constipation of a severe character is always present.

We next come to cases of stasis. The diagnosis of these cases is always "intestinal indigestion," etc., but if you will take the trouble to have x-ray plates taken, you will find that digestion is impeded by actual obstruction to some degree, or lack of tonicity of stomach or intestine. With the new controls at one's command there is no need of working in the dark and groping about with idiopathic diagnoses to explain what is now a most apparent condition.

In typical cases of stasis we always find a definite group of symptoms. Following a period of constipation with more or less attendant indigestion, anorexia, hyperacidity, bloating and feeling of pressure, all of which grow steadily more severe, the patient begins to have abdominal pain which may be described as dull and dragging, or colicky, or merely a constant sense of discomfort, relieved only by lying down. It is usually worse when standing or walking, or riding in a train or automobile. The colicky attacks may come on without apparent reason, and may or may not be accompanied by nausea and occasionally by vomiting, even of the most marked propulsive type. Distension is usually present, and may come on with great suddenness and severity. These attacks are relieved by morphia and belladonna, high enemata and cathartics, and are followed immediately by a copious discharge of mucus, — even as much as a quart at one dejection, — and in smaller quantities usually for several days. Following this "clearing out" the patient is apparently well for a time varying from days to weeks, when the cycle begins over again.

The severe acute attacks may simulate an acute intestinal obstruction, with increased peristalsis, violent pain, nausea, vomiting, anxious fancies and at times a small pulse, but there is rarely the prostration which we find in that condi-

tion, and furthermore, the obstruction can be relieved by the measures which I have mentioned.

All these phenomena are brought about by intestinal stasis, or, as I prefer to call it, "delayed traffic," which at times reaches an actual stop, with a resulting "smash-up." The passage of fecal matter through the colon being impeded by atony, kinks, adhesions or constriction bands, the colon fills up more and more, and we can readily understand the dragging pain, the headache, anorexia and distension that follow as a result of the fecal accumulation and the resulting auto-intoxication.

The location of the pain may vary with the situation of the "block." For instance, when there is obstruction at the splenic flexure the patient usually complains of griping pain in the region of the left upper quadrant, particularly when standing. If the cecum and ascending colon are particularly affected, the pain is on the right side, or even in the pelvis, which may, in women, give rise to the assumption of uterine malpositions, or of pelvic adhesions.

The elongated cecum, or even the most dependent part of a greatly elongated transverse colon, may occupy the true pelvis, giving rise to a dull heavy pain or feeling of weight in that region, and in the region of the sacroiliac joints. On account of pressure on the rectum these sensations are much increased on defecation, the patient feeling as if there were a mass in the bowel which cannot be moved. Furthermore, straining at stool merely increases the trouble, the abdominal muscles driving the large, engorged and perhaps inflamed bowel deeper into the pelvis.¹

On evacuating a long-blocked-up colon in one of these cases, we not rarely find in the overpowering stench, evidence of the putrefaction that has been going on, and so we are not surprised to find the group of symptoms of toxemia from absorption that we frequently see. Lack of energy, progressive loss of weight, and increasing staining of the skin

are the most noticeable features of this poisoning. The skin becomes thin, wrinkled, abnormally dark and "muddy" and the patient is said to look "bilious." At first this is a transitory condition, passing off with free purgation, but after a time it persists. The discoloration appears early, and is very marked in dark persons, and in such instances we may, together with certain of the symptoms, sometimes feel justified in making a diagnosis of Addison's disease. Besides the general "dirtiness" of the skin, we find areas of greatly increased pigmentation at the axillary and elbow folds, the eyelids, the groins, the labia and the inner surface of the thigh and in regions that are exposed to friction or pressure, as around the waist in corset-wearers and over the iliac crests and spines.

Another and almost constant symptom of the auto-intoxication is the marked mental depression and depreciation. The patients show all grades of neurasthenia, some becoming the typical "neurasthenic wreck," unable to concentrate the attention on anything, querulous and a burden to themselves and everybody else. As the neurasthenia may appear before any identifiable symptoms of colitis are evident, the colitis has been erroneously thought by some to be the result of the nervous condition, and thus the disease has received the opprobrious name of "hysterical colitis."

There is often noticeable about these patients, especially when the traffic is particularly delayed or a block has taken place, an unmistakable odor, hard to describe but suggestive of filth and similar to that noticeable in epileptics during a seizure.

Arthritis of varying grades from a slight "rheumatic tendency" to the severest incapacitating variety is seen not infrequently in these cases as a result of the autointoxication, and is relieved by restoring the proper functions of the bowels. Furthermore, the toxemia may be shown as an

irritation of the kidney, with slight traces of albumin, and renal casts in the urine.

The ptoses of the cecum, transverse colon and sigmoid are all characterized by similar symptoms due to their weight and abnormal positions and to partial obstruction. In prolapse of the cecum a kink is sometimes formed in the ileum near the ileocecal valve. As this dams back the contents of the ileum, fermentation takes place there, and the entire small intestine may become distended with gas, producing discomfort, distress or severe pain. The tenderness in these patients is quite characteristic. It extends from the umbilicus downward and slightly to the right and is easily distinguished from the tenderness over an inflamed appendix. The pain too, varies with the time of day, being worse when the abdominal wall is fatigued and lax, and increasing usually after the ingestion of food. It is also increased by any movement that brings a strain on the affected region such as riding, running and going up and down stairs.

When the sigmoid is at fault, either through dilatation and stretching, or adhesions or constriction bands, it is often very tender on pressure and can be felt through the abdominal wall. If it is adherent or constricted, the passage of feces through it may cause severe pain, and not infrequently it is this pain that brings the patient to the physician.

The embryology of the large intestine gives us some clue to certain abnormalities which we find. At birth the hepatic flexure is not yet formed, for the cecum lies in the right hypochondrium. It later descends, and this descent may be too slight or too great. In the latter case it may go even into the true pelvis, thereby forming a reservoir hard to empty. If it reaches Douglas' cul-de-sac it may give rise to the pressure symptoms of which I have spoken, and also it is very apt to become kinked, causing acute symptoms. Again, during this descent of the cecum in infancy, the

appendix or lower end of the cecum may become adherent to the posterior abdominal wall, giving rise to a retrocecal appendix and kinks in the cecum. If a cecal kink occurs in this way we are not unlikely to get a familiar group of symptoms, pain in the appendiceal region from distension of the appendix, together with headache, nausea, vomiting and general malaise from the attendant delay in the colonic traffic, of which the distended appendix is merely one element.

Furthermore the colon shows great variations in length, particularly in the transverse portion. Treves found that it varied from 12 to 33 inches and in one quarter of the cases he found that its most dependent part lay below the level of the iliac crests.² A festooned colon such as this must necessarily be sluggish in action, particularly in the presence of exaggerated hepatic and splenic angles which are very often found. These kinks obstruct the progress of the feces and thus harmful stasis and fermentation take place.

The sigmoid also is very variable, as its length has been found to run from 7 to 27 inches.³ An abnormally redundant sigmoid found together with sufficient symptoms is an indication for resection, but a long sigmoid without symptoms does not demand surgical interference.

Bands about the cecum may occur as a result of prolapse of that organ through the pull on strands in the peritoneum which attaches the cecum to the parietal wall, and at times these may make furrows in the cecum or even bring about kinks in it and the appendix.

Where the descending limb of the transverse colon comes in contact with the ascending colon and cecum, adhesions arising from the inflammation following the fecal stasis at the kink may unite them directly to one another. This may also occur on the other side of the abdomen, between the ascending limb of the transverse colon and the descending colon. This already great obstruction to traffic becomes

increased by the accumulation of feces in the transverse colon which drags it down and accentuates the kinks.

As regards the etiology of the inflammatory adhesions, a single band is usually the result of some local inflammatory lesion, such as an ulcer of the colon, inflamed glands, perigastritis over a gastric ulcer, or inflammation around an appendix or a gall bladder or a diverticulum. All these things with more widespread peritonitis may cause multiple adhesions and bands, as may also perityphlitis in typhoid, or pelvic inflammation. An inflamed appendix may be so long as to form adhesions between itself and other portions of the colon, most frequently the sigmoid. Extensive adhesions may usually be traced back to a general peritonitis, but there are cases in which there is no satisfactory explanation.

In one of my cases, to which I have already referred, the etiology of the adhesions was traced back to an attack of peritonitis in the patient's childhood, fifty years ago. Until shortly before operation there were no symptoms, then suddenly, probably on account of a gradual wearing out of the muscular coat of the intestine and further contractions of the adhesions, colitis appeared with extremely severe symptoms. In fact most of my cases have been in adults beyond middle life in whom the original inflammation took place in childhood. The manner in which the adhesions and bands cause the colitis is probably by giving rise to fecal stasis with consequent local irritation and inflammation of the mucosa.

As I said at the beginning of this paper, adhesions and ptosis go hand in hand, for dilatation and elongation of the proximal intestine are the natural result of long-continued effort to force material past an obstruction. This, however, is by no means the only cause of ptosis, for we find it not infrequently in persons who have lost much weight, and in women whose abdominal walls have been made flaccid and nonsupporting by pregnancies.

After visceroptosis has existed for a considerable time, changes occur in the transverse colon. We find the normal pouches or sacculations between the longitudinal muscle bands become larger, the whole bowel is stretched and more capacious, and the muscle coats atrophy, resulting in atony and inability of the colon to do its work. In such cases chronic inflammatory changes in the mucous membrane giving rise to symptoms of mucous colitis are common.⁴

When we find that a patient must continually resort to severe purgatives and drastic enemata, particularly if there is also tympanites and painful peristalsis, we must consider the presence of some serious anatomic or pathologic defect.⁵

Mummery collected twenty-four cases of "angulation or kinking of the colon causing severe chronic constipation or complete obstruction and in which the condition was verified at operation or post mortem." He says, further, that "unless angulation is suspected and carefully sought for, it may easily be overlooked, even at operation, when the abdomen is explored. The kink often occurs only when the patient is standing, and the force of gravity can pull down the pelvic colon deeper into the pelvis. When the patient is recumbent, as he naturally will be during the operation, no kink may be seen."⁶

And *à propos* of this, Lane says "the conditions presented by the viscera of a patient properly prepared for operation give one as little idea of those which exist in ordinary circumstances as do those shown by a case of varicose veins of the leg similarly prepared."⁷

These abnormalities of the intestine are very clearly shown by the x-ray, but it is not safe to rely entirely upon x-ray plates, for we may find very marked malpositions of the colon and a very large sigmoid without any interference with function. Operation is demanded only in the presence of marked symptoms, for it is probably only the exceptional case of coloptosis that gives trouble — and, in this connec-

tion, Ochsner says that he finds in 25 per cent of his cases operated on for other conditions, marked ptosis of the colon which has never given trouble.⁸

And now we come to a most distressing class of cases: those of atonicity of stomach and intestines.

On account of chronic obstruction the digestive tract becomes tired out and unable to perform its functions normally, even with the aid of diet, drugs, electricity and massage. It has been whipped and stimulated, but now at last "lies down," tired out and thoroughly beaten. It ceases to respond to stimuli of all sorts, and it is then that we are forced to resort to surgery, but alas! too late in many cases, for although we seek to remove the obstruction, and in every way make it easy for the bowel to work, the reaction time has passed. The muscular coat of the intestine has become worn out and although we take off the load, the poor intestine has no "kick" left. You may take out the colon, free adhesions, do a hammock operation on the colon, but it will not work, for the "gimp" has gone and no power on earth can bring it back.

These are sad cases and we are only too apt to blame the surgeon because his operation fails to relieve. The real trouble lies with us, because we have not made our diagnosis early enough and called in the aid of surgery while there was yet life and strength in the intestine.

I speak freely on this point, for in the past year I have seen several such cases for which there was no help and no relief except death.

Fortunately in many of the milder cases we can bring relief by medical means. What, then, shall be our treatment of them?

Laxatives. It has been my experience that licorice powder is of the greatest service, as is also the use of agar-agar, especially in conjunction with a diet largely of vegetables. Small doses of real cascara (and I say real cascara because

I believe that most of our so-called cascara is of little use) given three times a day are valuable, or if the case responds better to salines, the use of sodium phosphate three times a day. Where colitis is present, small doses of salol and castor oil are of the greatest service, and where toxemia exists great help is afforded by the exhibition of calomel once a week. High irrigations, oil, — either by mouth or by enema, — a coarse diet (vegetables, fruit, bran biscuits, coarse cereals), exercises and abdominal massage may also be employed to advantage.

In the acute attacks, however, simulating intestinal obstruction, nothing gives relief except the administration of morphia and belladonna. This relaxes the spasm and allows the passage of mucus and feces often in enormous amounts shortly after. Following this, irrigation of the entire colon — which can be done only by an expert — accomplishes a thorough cleansing of the bowel.

Recurring attacks of this sort, however, point to an obstruction to the permeability of the bowel, and if nothing else can be found to account for the symptoms, operative interference is indicated. In some cases an appendicostomy may suffice, since in this way through-and-through lavage of the colon may be effected whenever there is apparent any tendency to stasis. In the more severe cases nothing will do but an exploration of the whole abdominal cavity, and the freeing of adhesions, division of bands and stitching up of a prolapsed cecum or transverse colon, or resection of a portion of a redundant sigmoid.

These measures sometimes bring complete relief, but in some cases the colon has lost so much of its muscle coat, and has become so stretched and atonic that months of treatment by strychnia, laxatives, massage and warm irrigations of salt solution may be necessary to restore the tonicity and bring the bowel back to something approaching its normal condition.

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ARTICLE IX.

THE OPERATIVE TREATMENT OF
GASTROENTEROPTOSIS.

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DELIVERED JUNE 11, 1912.

THE OPERATIVE TREATMENT OF GASTROENTEROPTOSIS.

IN being invited to present a surgeon's solution of a very complex problem before so distinguished a body as the Massachusetts Medical Society, I am conscious of having been signally honored. For this I am sincerely grateful. Whether your program committee exercised wisdom proportionate to its generosity in choosing me to present the surgical aspect of visceroptosis remains to be seen. For in the beginning it is proper to remark that the views to be expressed, while held by a growing number, are at variance with those expressed by the majority of surgeons. They are personal convictions, however, which have come to me and have been made firm as experience has grown ripier.

From the report of the combined meeting of the American Gynecological Society and the American Surgical Association in the transactions of the latter for 1910, and again from that of last year, it will appear that the patient with visceral ptosis has been definitely given a passport to the domain of the internist, from which the orthopedist may get him by requisition. Where many men of large experience and great authority in matters surgical hold out against operative interference, it requires conviction born of a series of successes to advocate the use of the knife, when other measures have failed, and this conviction I have. It is to be regretted that ptosis of the abdominal viscera was always considered by Glenard as only a part phenomenon of a very complex condition. Doubtless in many cases this is true, and if the condition is not congenital, it develops early in life, is often

hereditary and is unmistakable. A young woman, more rarely a male, without any pathologic causes of tissue relaxation, has stooped shoulders, a dry skin, prematurely wrinkled, breasts pendulous, and an abdomen flabby like that of a woman who has given birth to many children. The hernial apertures are relaxed, the uterus retroverted and the stomach often dilated. There is a general tissue insufficiency as often manifested, for example, by a condition which does not seem correlated, namely, a flat foot. The circulation is poor, the muscles even in action are feebly outlined. The patient, while young, is habitually tired, psychically depressed, usually pessimistic, in short a confirmed neurasthenic. Here is a condition, which might well be termed panoptosis and in which the surgery, which I have the honor to represent on this occasion, can offer but little.

Since this condition is easily recognized during the growing period of the child, the postural combined with the mechanical treatment, if instituted early enough, must certainly be of great benefit. There is, however, another large class of cases, in which the sagging of the abdominal or pelvic organs is associated with remote effects, which hardly seem correlated. They are attributed for the main part to the results of intestinal stasis. It is from this center that much of our knowledge of the relation of this condition to rheumatoid affections has emanated. These are, however, minimal in importance to the neurasthenic states, which we are coming to believe are largely a result of chronic auto-intoxication of intestinal origin.

Despite the fact that the latest German authorities have discovered an increase in number of intestinal bacteria proportionate to the frequency of the stools, it seems clinically certain that absorption from the large intestine during stasis is deleterious to the nervous system, and if long continued, engenders a flood of phenomena vaguely called nervous.

To dwell upon the latter is beyond the purview of this paper. But it is because of their preponderance that the sufferers therefrom are often passed from one specialist to another without obtaining a careful analysis of their cases. It is manifestly impossible to dwell at this time on all the abdominal ptoses without abusing the privilege you have given me. I shall, therefore, limit myself to the consideration of those of the gastrointestinal tract. But one feature is common to them all, namely, that the nervous habit is as easily acquired and becomes as easily fixed in the visceroprotic as is the universally recognized epileptic habit, in which even after the successful removal of the cause, as, for example, from depressed fracture, the symptoms soon recur. It must be made plain that if anything is to be accomplished for the relief of the nervous manifestations of visceroptosis, the measures indicated in the individual case should not be delayed. Fortunately our methods of diagnosis have been so quickly advanced that when the indications are clear, a radical treatment need not be long put off.

It is to be regretted that in ptosis of the abdominal viscera, the clinical manifestations bear no fixed relation to the form or the degree of sagging. A complete prolapse of the uterus often causes less disturbance than a relatively slight retroversion that is fixed. A movable kidney that can be displaced from the loin to the pelvis may produce no symptoms at all, while one that moves but little beyond the normal limits may, by reason, for example, of an anomalous vessel, give rise to painful and often serious obstruction, which nothing but operation will relieve. By way of digression I may here call attention to the conservatism which surgeons generally are displaying in regard to fixing movable kidneys. We are all fixing fewer kidneys than formerly, because the operation, as a rule, failed to relieve the nerve symptoms which were erroneously attributed to nephrop-tosis. Particularly are the displacements of the stomach

and of the various segments of the colon of widely varying importance in the causation of either local symptoms or those that may be termed neurasthenic. Fecal stasis in one individual may not be at all deleterious, whereas in another it produces a toxemia of which we are just beginning to appreciate the protean manifestations. A stomach occupying the upper pelvis may perfectly perform its function, while, another, much less prolapsed, may be delinquent through lack of tone or pyloric angulation.

In seeking the mechanical, including the operative therapy, for visceral sagging, it is, *a priori*, necessary to consider where the fault lies in the forces concerned in keeping the viscera in their normal positions, and in stimulating them to function. Of these the equable atmospheric pressure is the only one that never varies. The musculature of the abdominal wall including, of course, the diaphragm and its attachment to the fascia, plays a very important role. The movements of the colon, rather inactive during the sleeping hours, are stimulated to activity by the first muscular exercise incident to rising and dressing. Of course, an ample breakfast helps along. Every clinician must cope with the tendency to constipation attending confinement in bed. My excuse for recalling these elementary observations is the fact that in the fixation operations for the acquired types of ptosis, which, of course, are in the minority, the relaxed abdominal wall is generally ignored and remains a potential factor in the etiology of recurrence. But the visceroptosis which results from the failure of its muscular support differs essentially from that which is congenital in origin and in that the neurasthenia so common in the latter is far less frequent. It is only necessary to recall the equanimity with which wide diastasis of the recti or ventral hernias amounting almost to evisceration are borne with only local effects. The overshadowing factor in the etiology of this condition is some congenital variation in the embryonic

process of parietal fixation of the different parts of the intestinal tube. The more we analyze our cases of visceral ptosis, the more we find a history dating back often to childhood with symptoms increasing as age advances.

The variations in the fully developed adult visceroptosis are almost innumerable, but they appear to me secondary to two primary or general conditions, which as yet have not gained the recognition they merit.

The first and more important of them I believe is the insufficient fixation of the cecum and of the lower part of the ascending colon. The second is the relatively high fixation of the splenic flexure of the colon with consequent sharp angulation at this point. That a mobile cecum should be a factor in any morbid condition cannot be readily conceded, because it is so often found without producing symptoms. Indeed, every fifth child is born with a mesentery for the entire colonic length. The recumbent posture of infantile life doubtless prepares the child for the erect posture of later life. It helps to fix the colon and makes of it a retroperitoneal structure by the time permanent functions of absorption and inspissation of waste products are to be established. In every tenth subject, of 640 cadavers carefully examined, Wandel found the cecum and lower ascending colon completely enclosed and mobile to a degree permitting torsion, kinking or displacement. Twenty-eight of them he found in children, thus bearing out the hypothesis I have just advanced.

It is in the cecum that the fecal current is first arrested after being rushed in a little more than two hours through the many feet of small intestine, and it is here that stasis normally occurs. Without the support given by fixation, cecatonny, as Fisher calls it, is likely to ensue and with it all the secondary local and general manifestations incident thereto. In the cecum and the colon adjoining bacterial activity reaches its climax. In the event of inadequate or

delayed drainage the symptoms of autointoxication become pronounced and finally as Pilcher has recently put it, neurasthenia in some of its many forms crowns the process.

It is a far cry from mobile cecum to neurasthenia, but it is making itself heard. A prolapse of the head of the colon may give no evidence, whatever, of its presence and be discovered at operation and then often have its causative significations completely overlooked.

Every surgeon has occasionally removed a long freely movable and nearly or quite normal appendix on the diagnosis of chronic appendicitis. They are cases without the history of acute and febrile attacks, but in which the symptoms are evanescent, colicky attacks, ill-defined gas pains and above all constipation with the endless train of nerve symptoms, which it so often begets. If the pains recur after operation, we lightly ascribe them to adhesions or neurasthenia. We remember these operations as easy ones, because the cecum, although perhaps at first not readily found, because the ascending or transverse colon would get in the way, could, when found, be easily drawn into the wound together with a good part of the ascending colon. I have found this condition not only in multipara but quite often in young children and in adolescents of both sexes.

In its symptomology the condition greatly resembles the pseudo-appendicitis of Nothnagel. What actually occurs is a ptosis of the mobile cecum, of a mobile ascending colon or of both. In the very young a pericolicitis with the film-like vascular covering does not occur. But I have seen it now in seven cases of what appeared to be primarily a mobile cœcum. The following is the most interesting of the neurasthenic cases of this kind that has come under my observation.

Mrs. T., aged 40, the mother of three children, has for the last eight years suffered from obscure pains in the lower right abdominal quadrant. Has always been the subject of

chronic constipation. Headaches were of frequent occurrence and at times, when the constipation was especially prolonged, she had attacks of vomiting. The severe pains were paroxysmal in character and were believed to be due to a loose kidney. The course of the disease was afebrile. Relief had been sought by the patient at many hands, but without success. She had become neurasthenic. The statement was made that during her paroxysmal attacks a painful swelling appeared in the right lower quadrant, which was believed to be the distended prolapsed kidney. Urinalysis negative. Ureteral catheterization with a leaded catheter and radiography revealed a phlebolith one-half inch removed from the ureter. On the right side there could be moved under the examining fingers the distended head of the colon, from which, under pressure, the contents escaped. The operation revealed a normal appendix, the cecum and lower portion of the ascending colon enormously distended and in the lower part distinctly movable. Velamentous injected adhesions covered the surface of the cecum, and one band, distinctively obstructive in its effect, stretched like a wire over its front. With the division of this band and all the lesser ones in reach an ocular and aural demonstration of its obstructive effects was given by the emptying of the colon with a gurgling sound. The operation was completed by the removal of the phlebolith from the pelvis. Constipation, pain and neurasthenia have gone together.

Except for the phlebolith found in this case it fairly typifies a condition which should be regarded as a distinct morbid entity. Experiences are rapidly multiplying to show that, although the appendix still occupies by far the most important place in acute affections of the iliocecal region, there are many cases in which it is subordinate in importance. This, notwithstanding the dictum of Kelly that primary typhlitis is among the rarest of diseases. The remark of Deaver that stercoral typhlitis may occur, I do not deny;

that it does occur I do not believe. If with a normal or nearly normal appendix conditions such as have been described are found, we must look for another cause. I believe it to exist in congenital malformations of this region, which, with the tendency to fecal stasis, torsion and infections, short of the suppurative, give rise to very varied anatomic changes. Just as nonperforative affections of the gall-bladder, of the stomach or of the uterine appendages can produce changes in the adjacent peritoneum, so a distended cœcum or colon may give rise to adhesions, which may assume the form of the thin vascular film-like membrane so well described by Jackson, or to firm white fibrous bands, which more or less constrict the bowel lumen. That this is the result of a low grade of infection is made probable by the observations of Hoffmeister, who in ten cases found the tricocephalus dispar outside the gut wall. That deformities notably of the appendix and occasional kinking of the ilium should often result is self evident. It follows, of course, that the removal of the appendix alone cannot be curative. For this reason it has long been a question in my mind whether the very short incision, now so universally made in the interval appendix operations, is the best to use in all or even in most cases. Surely in the cases under consideration, more room is desirable, both for exploration and for instituting the necessary remedial procedures. A long pararectal incision can be made in the beginning, since fortunately a distinct clinical syndrome results from the conditions described, and both by touch and by radiography a diagnosis can be made. I believe that the pericolic adhesions are only the result of an unsuccessful effort of nature to overcome a congenital defect, which surgery alone can successfully correct; and procrastination is here as elsewhere out of place. In cecopexy, combined with cecoplication when typhlectasia already exists, we have a safe method of overcoming primary cecal stasis, and which if done early enough will do away

with the various exclusion operations, which threaten to become the fashion.

This brings us naturally to the typical prolapse of the midcolon with its angulations, its long history of indistinct, ill-defined abdominal symptoms, the necessity for daily cathartics and all the far-reaching consequences of constipation. There are few as yet, who follow where Lane has led, but we are indebted to him for a clear, explicit and bold pronouncement of the causes and dire local and general results of fecal stasis. No one else, with the exception of Metschnikoff, has so clearly portrayed the deleterious results of colonic autointoxication. More than any other he has clarified our understanding of the progressive nature of a condition in which, according to its severity, the operative procedures to be undertaken must be proportionate.

A festooned colon reaching to the pelvis is abnormal. At a right angle it should pass horizontally from right to left and from about the midline gracefully ascend to the splenic flexure, where under a more or less acute angle with consequent almost natural valve formation, it passes into the descending colon. The splenic flexure is the most fixed and the highest point of the colon. Its attachments to the diaphragm are firm and the angle naturally divides the large intestine into two parts, the proximal of which is always more or less filled with feces, whereas the anal portion is practically empty and serves only as a passageway before the final expulsion. The attachments of the hepatic flexure are very much less firm. Overfeeding and inattention to regulating intestinal evacuations are liable to make the first changes in the transverse colon, when it is overloaded. The fibrous band, which we so often see at the hepatic flexure, looks like a misdirected effort to sustain the lowered arch at this, its proximal end. If the hepatic flexure does not sink, the angulation here in turn produces complex changes in the cecum and in the ascending colon. How

large a part antiperistalsis, a physiological factor, which we must recognize, plays in the development of the conditions described as a result of ignoring the calls of nature, cannot be determined. But retrogression of the fecal current has been often demonstrated by radiography. On account of the lower level of the hepatic flexure and its loose attachment, the descending limb of the prolapsed colon readily lies in contact with the distended ascending colon, and when the film-like adhesions occur, the well-known double barreled shotgun arrangement of these two segments of the colon is formed. Fortunately, the sagging transverse colon is, as a rule, mobile. When it is fixed it is usually from or associated with some lower abdominal lesion, which the x-ray may not have revealed. Surprises sometimes come in this manner.

Several months ago I operated upon a virgin with marked coloptosis. The symptoms of neurasthenia were pronounced. There was nothing to indicate ovarian disease. The operation revealed a sagging transverse colon fixed through the omentum to a tuberculous mass involving the left tube, which was removed. The patient recovered more promptly from the operation than did the surgeon from the chagrin of having relied almost wholly on the x-ray for diagnosis. Nevertheless, radiography is entitled to the first place in the diagnosis of the manifold variation of visceroptosis, and without it any operation for its relief is made in the dark.

Recently I saw a man of forty, extremely neurotic, constipated for many years, with suffering of indistinct character in the lower left quadrant. His nutrition was excellent. There was no tenderness, nor could a tumor mass be felt. Repeated examinations were negative as to occult blood. A half dozen x-ray plates, which were taken, all showed a V-shaped pendulous transverse colon. Whether the bismuth was introduced from above or below, there was one

section of the lowest part of the descending colon about two inches long, in which the bismuth was never found. It corresponded to the place of which the patient complained. The operation revealed a tight band extending from the outer surface of the gut and nearly shutting off the descending colon from the sigmoid. Its cause could not be elicited. The band was easily lifted on a spatula, divided and excised, whereby the lower segment of the colon was freed. A peritoneal plastic completed the operation. The constipation and the pain have been relieved, and with them have gone the general concomitant symptoms.

It is evident that every case of fecal stasis must be studied individually and that the adoption of any routine procedure, except the radial ileosigmoidostomy of Lane, must be unsound. Notwithstanding the brilliant results of its originator, this is an operation to be reserved for extreme cases. The exclusion of the large bowel may have demonstrated that it is an unessential part, and that a time may come when total colectomy will be advocated by way of prophylaxis against arteriosclerosis. At any rate Diastaso followed thirty-six of Lane's cases for three or more years, examining the evacuations bacteriologically. The patients remained in good health, and gained in weight and activity. But in other cases retroperistalsis forced this operator to excise the colon in whole or in part. Some operators overcome this by draining the colon through a cecostomy, which in my judgment is rather too nasty a wound complication for a condition that in and of itself is rarely dangerous.

Fortunately, such radical measures are uncalled for in the common type of ptosis of the transverse colon, the primary case of which is the high attachment of and consequent sharp angulation at the splenic flexure. As Payr has shown it is sometimes possible to bring the splenic flexure to a lower level by dividing the fibrous bands which hold it. When this promises to be difficult the routine operation

should be colopexy by which the arch of the colon can be brought and fixed in relation with the anterior abdominal wall in a plane two inches or more above that of the umbilicus. This operation of Coffey is my routine procedure (in the cases under consideration) to which I add, as the case may demand, reefing of the mesocolon or, where the gut is particularly redundant, a coloplication. To make the operation effective the suspension must be made, as far as possible, on both sides of the median incision. The lesson learned, that peritoneal adhesions are readily stretched and may even disappear when peritoneum is sutured to peritoneum as in ventral fixation of the uterus, has a practical bearing on the fixation of the colon. For this reason I divide the peritoneum of the anterior abdominal wall along the line of proposed fixation and expose the fascia from within. Into these denuded spaces the omentum is fixed by a continuous suture. This procedure is analogous to that proposed by Nogarth for cirrhosis of the liver. In properly selected cases this operation is safer than an anastomosis operation, and serves every purpose, but is not entirely devoid of danger. In one of my cases of cirrhosis death followed the operation on the fifth day from thrombosis of the gastric veins. The signal advantage of colopexy thus performed is that it restores the natural, though always weak shelf-like arrangement of the transverse mesocolon above which the stomach, which is so often prolapsed, is restored to its place. By none of the anastomosis operations is this accomplished. Regarding the latter there have been many variations by which the cecum has been joined to the descending loop of the transverse colon. Hoffmeister, for example, performed this cecotransversotomy in twenty-three cases with uniform success. Where the primary angulation is at the splenic flexure, if an anastomosis operation is to be done, it is preferably made between the sigmoid flexure and the ascending limb of the prolapsed colon.

The more one sees of ptosis of the colon, the more evident it becomes that no one operation is applicable to all cases. A careful study of the radiograph and then of the actual conditions, as seen through a large incision, will determine the operator on the proper method of procedure. Fixation operations of the cecum, of the transverse colon or of the sigmoid, according to the indications, have in my experience sufficed, and if performed sufficiently early, will, I think, make unnecessary the decidedly more dangerous exclusion operations.

GASTROPTOSIS.

The intensive cultivation now practiced in the field of coloptosis has caused us of late to overlook the prolapsed stomach. Whereas it is true that in most instances the prolapse of the colon entails a sagging of the stomach, the cases are far from rare in which the prolapse of the stomach is either primary or the only malposition present. Nor must it be forgotten that where the combination exists, very many of the symptoms are gastric in character and these cannot, in my judgment, be relieved by any operation except the fixation of the colon, and incidentally of the stomach. No exclusion operation can effect this. The stomach, of course, has supports that are independent of the colon, although in a normal condition it may be said to rest on the left half of the colonic arch on a shelf formed by the transverse mesocolon supported by the loop of small intestine. Furthermore, the attachment of the pylorus to the diaphragm and of the duodenum to the liver, and of the fundus to the spleen and splenic flexure assure the stomach an independent support. I would insist upon the fact that good results were obtained by stomach fixation before operations on the colon became generalized. A few days ago a young woman of 31 reported to me, upon whom, five years before, I had performed a gastropexy with

gastroplication. Before that she had run the gauntlet of specialists without avail. Postprandial distress, eructations of gas, occasional vomiting, persistent constipation and so on had been complained of for fully eight years. Her weight was very much reduced and her suffering had played havoc with what I was told was naturally a sweet disposition. Marriage and the birth of a child did not mend matters nor make them worse. When she entered the hospital she weighed 96 pounds. An x-ray revealed the fundus of the stomach resting on the iliac pan and extending across the pubic arch to the right side. The upper border of the bismuth shadow was a level line. It looked like the flabby cheese bag of long ago. The picture taken two hours later showed the contents scarcely changed and fully two-thirds of the ingested milk of bismuth were still in the stomach twelve hours later. The gastric atony was most marked. The stomach held two quarts of fluid comfortably and without revolting. A gastropexy or rather an omentopexy with gastroplication was performed. X-ray pictures taken a week later showed astonishing results. The stomach was in the best vertical position with the pylorus low. Within five minutes of the ingestion of the milk of bismuth the motile function was in action. The wall of the stomach fitted to its contents like the skin to the sausage. This woman has continued well, does all her own housework and is unconscious of having either a stomach or nerves. Incidentally her normal weight is between 115 and 120 pounds.

There is hardly a branch of medicine in which radiography is as helpful as in the one under consideration. The old classical anatomical illustrations, so familiar to us all, of the transverse or oblique stomach, do not correctly represent the viscus in vivo and at work; nor do the internists fairly show its everyday working capacity, when they analyze what it can do with a test meal, a piece of toast, a small piece of steak and a glass of water. A stomach may be

able to dispose of this and secrete the conventional two per cent of hydrochloric acid, and still be totally inadequate to the ordinary demands made on it in the every day mode of eating and drinking. The merit is the radiologist's, who has shown us the wide variations in the position of the stomach in the normal individual and the speed with which it all but shoots its contents through the relaxing pylorus.

Deficiency of gastric secretion, while doubtless important, is less so than motor insufficiency, since the ingested food stuffs are subjected to other chemical influences in the small intestine, whereas, motor insufficiency cannot be compensated for and must, if long continued, lead to gastrectasia, the symptoms of which need not be here enumerated. I cannot refrain, however, from alluding to the frequency with which the symptoms of gastric ulcer come in young women in whom a gastropotosis is either overlooked and perhaps not recognized as the initial cause.

There is a tendency among clinicians to divide gastropotoses according to the degree of sagging, the extreme cases being those in which the fundus and even the pylorus may be in the pelvis. Any attempt at classification as a basis for operation is, in my judgment, ill-advised, because very many stomachs are markedly prolapsed without disturbing digestion. More important far than the position of the stomach is its tone, as shown by the x-ray and particularly the presence of what is akin to an antral sphincter showing as a constriction some inches from the pylorus. In considering gastropotosis from x-ray findings we are justified in dividing them into two classes. In the first the stomach retains its vertical position and the pylorus, although prolapsed, still occupies a low point. In the second the stomach occupies a transverse or oblique position in which the greater curvature and fundus are greatly depressed, the pylorus remaining on a higher level. It is in this class of cases, even if the prolapse is of moderate degree,

that the functional disturbances are very much more pronounced, because of the angulation which occurs at the gastroduodenal junction and because the chyme mass must be lifted uphill.

The relation of gastropptosis to mobile cecum and prolapse of the colon has been made particularly clear by Klose. Quite recently MacLaren called attention to a number of neurasthenic cases in which the appendix had been removed without more than temporary benefit. In a number of them a sagging stomach was found, and great relief was afforded by placing the patient in the recumbent posture after every meal. Internists and orthopedists have also recommended this postural treatment. Gastropexy aims to do this in a definite and permanent manner.

The all important question of the relationship of so-called nervous conditions and of gastric disorders to each other can here only be touched upon. Suffice it to say that the influence of the nervous system on the digestive functions beginning with the salivary secretion and ending at the anal sphincters has been recognized from time immemorial. To make this influence responsible for the chronic inactivities of the stomach and colon is not warranted by this physiologic relationship. On the other hand, the baneful effects of visceral sagging on the nervous system have been removed sufficiently often and permanently by operation to warrant, in my judgment, the assertion that the ptosis is the cause in very many cases of the neurasthenia.

There is a German adage, which is applicable to the treatment of visceral ptosis. It is, "where there is no plaintiff, there can be no judge." In other words, extreme intestinal sagging accidentally discovered should be let alone, like similar nephroptosis. When, however, it gives rise to functional disturbances, which may appear slight when compared with the manifestations on the part of the nervous system and which make for invalidism after reasonable

efforts at conservatism have failed, it is my judgment from the experience of some thirty operative cases, that operation should be resorted to with at least a fair prospect of permanent relief.

An operation for visceroptosis should not be a haphazard one. Since the stomach and colon often sag together, the one should not be lifted without the other. It is not my purpose to go into technical details, but I may be permitted to say that the median incision should be rather long than otherwise. Particularly, when the abdominal wall is greatly relaxed, such an incision permits a plastic operation whereby the replaced viscera are held in the upper abdomen, where they normally belong. This repair of the abdominal wall is as important as that of injuries of the pelvic floor. It makes a living abdominal support to take the place of the ingenious mechanical device of the orthopedist. This matter is so important that Rovsing makes a distinction between ptotic women, who have borne children and those who have a virginal, strong abdominal wall.

In visceroptosis operations should not be multiplied. It has been the history of many of these cases that one operation after another has had to be performed. Coffey has very well insisted on the necessity of doing all the suspension work necessary at one sitting. The following case is one of the number, which I should cite by way of illustration.

P. W., aged 40, was admitted to the Jewish Hospital on the twentieth of March, 1910. For many years he had been suffering from abdominal distress, notably after eating. There never was any sharp pain. Only at times were the pains cutting in character. The nature of the food did not influence them. There was always a sense of bloating with gas eructation. The latter disturbed him very much and at times became uncontrollable. At infrequent intervals he vomits and headaches are of frequent occurrence. Constipation is habitual, no movement occurring without the use of cathar-

tics or enemata. He is frequently unable to follow his business pursuits, at times has difficulty in breathing and suffers from sleeplessness.

Present condition: Anemic, fragile-looking adult; weight 103 pounds. Is prematurely gray. There is a slight subicteric tinge of the skin. Heart and lungs normal. Urinalysis negative; stool examined for blood, examination negative. On pressure, there is some tenderness in the epigastric region. The liver appears somewhat mobile and the dilated gall bladder can be readily mapped out. The stomach analyses, which had frequently been made by a number of specialists, showed an atonic stomach without any evidences of ulceration. The x-rays taken by Dr. Lange showed a gastropotosis with the fundus reaching to near the iliac crest and the pylorus on a higher level opposite about the fourth lumbar vertebra. The axis of the stomach was nearly transverse. The transverse colon was in the pelvis and angulated. The operation in the median line permitted the fixation of the stomach and colon by omentopexy, gastroplication and the drainage of the distended gall bladder. Although it would have been easy to duplicate and shorten the suspensory ligament of the liver, as has been done by a number of German operators, I believed this step unnecessary. This patient made an uneventful recovery.

At the present time he weighs 130 pounds, eats whatever pleases him and the stock of cathartics which he had on hand has not been diminished since the operation was performed.

There is no better judge of the nervous and mental state of a man than his wife. In answer to my inquiry as to his condition his wife said, "You have made a new man of him."

Although gastroplication has, by very high authorities, been condemned I still practice it, and I believe with good advantage. I am convinced that it adds to the rapidity

with which after fixation the stomach regains its tone. The distension of any hollow organ for a long time, whether it be the stomach, the heart or the bladder, weakens its musculature. A hyperdistended bladder from obstruction may never regain its tone after the primary cause has been removed. By reducing the size of the stomach, even moderately, its motor function is facilitated and its work actually reduced in proportion to the reduced capacity of the organ.

The procedures for fixing the stomach vary. The shortening of the gastrohepatic omentum, the operation of Beyea, has never impressed me favorably, since the function of this omentum as a suspensory ligament is negligible, except so far as its right and left borders are concerned. It is only fair to state, however, that with many this is the operation of choice, and Beyea two years ago reported on 26 cases, with only two failures. Gastroenterostomy has also been performed for the relief of the dilatation, but has little to recommend it. Indeed, many of the failures of this operation can, I think, be attributed to its having been performed where ulcer was suspected, when the primary condition was a sagging of the stomach. In my judgment, then, the proper procedure for lifting the stomach, and with it in most cases the colon, is omentopexy with the details of technique to which I have already alluded. While I do not believe that the stomach should ever be directly fixed to the abdominal wall, I would consider this paper incomplete without alluding to the very large experience of Rovsing, who three years ago in Volksman's *Sammlungen*, and again before the International Surgical Congress reported on over 75 cases with most remarkable results. In a recent conversation with me Rovsing stated that he had performed this operation over 150 times, and that he had collected nearly 100 operations by his colleagues in Denmark. His operation consists of passing three sutures through nearly the entire

thickness of the wall of the stomach, and passing them through the entire thickness of the abdominal wall.

In conclusion I beg to submit the following theses summarizing my views on the operative treatment of gastroenteroptosis.

(1) Every case of visceral sagging should be studied individually and should not be treated in a routine way, whether conservatively or by operation.

(2) If after the removal of the normal or nearly normal appendix the patient continues to suffer, he should not be lightly classed among the hopeless neurotics. It is probable that the surgeon has overlooked some visceral displacements or adhesions, which are the cause of the suffering.

(3) A small incision in abdominal work of the kind under consideration has signal disadvantages.

(4) The conclusion of the internists based on laboratory findings as, for example, after ingestion of a test meal, cannot be made the basis of the functional capacity of the stomach under everyday conditions.

(5) In many seemingly hopeless cases of gastroenteroptosis with marked neurasthenic symptoms, operation promises relief. If this is the result of suggestion, it is none the less valuable if the relief is permanent.

(6) While, of course, internal treatment, abdominal supports and postural treatment should be tried, operative interference should not be unnecessarily delayed, lest the habitus nervosus becomes too deep-rooted to be eradicated.

(7) No gastropototic patient should be operated on unless some actual functional disturbance can be demonstrated. To relieve this must be the aim of the operation.

(8) Given a visceroptosis in which we can demonstrate distinct functional incompetence or deviations the existence of nervous phenomena does not militate against operation but may be the chief reason for performing it.

ARTICLE X.

ALIMENTARY ABERRATIONS; THE ROENT-
GEN RAYS AS A FACTOR IN THEIR
DIAGNOSIS.

BY PERCY BROWN, M.D.
OF BOSTON.

DELIVERED JUNE 11, 1912.

ALIMENTARY ABERRATIONS; THE ROENT- GEN RAYS AS A FACTOR IN THEIR DIAGNOSIS.

Those of us who are here gathered at the annual event of this hiatus in the humdrum of routine have lived, and are living, to see our profession undergo developments of profound moment and import. The older of you can well remember when each, as a medical practitioner, could hold up but one hand and enumerate upon the fingers of that hand his entire diagnostic assets, each finger corresponding to one of the five especial senses given him by his Creator. We, who are younger, cannot so clearly remember such an epoch, but we have heard of it, wondering the while what we should have done, or what sort of medical men we should have become, possessed of aids to our efficiency enumerated by the distal phalanges of but one hand and with the other hand tied behind us.

Here we stand, on the contrary, surrounded by laboratories filled with glistening vessels of the newer chemical reagents, with microtomes and microscopes shining in the effulgence of a veritable rainbow of staining fluids, and we are weighted down with the knowledge necessary to discourage the mosquito and the house-fly in the very womb of their villainous careers. We are obliged no longer to resort to our sense of touch to entice the elusive fracture fragment; but, by worshipping for a while at the shrine of Vulcan, we can clamp it into place once for all with bonds of metal. Both hands are free to use the ultra-violet band of the spectrum for the purpose of recording photographically

microscopical structures which, heretofore, not even the microscope could tell us of; hands free for manipulating the sources of the x-rays of Roentgen, by the action of which the integument of man no longer conceals his inner workings from the interested gaze of his fellows; and there is no one of the substances which he may naturally, or unnaturally, secrete from his body, about which he cannot have the most precise information within twenty-four hours!

Narrow-minded indeed is he who would carp at the advancement of scientific knowledge, yet such means as these for obtaining specific information may not be without their deleterious effect upon us as practitioners — as practitioners, let it be repeated. Our predecessor who possessed naught but his five senses had developed in him, through very necessity, traits and qualities as a medical man which we may be in danger of losing. Let us not, in our possession of the array of diagnostic implements which Science has given us, lose sight of those bequeathed us by Nature. In our dependence upon the former, although they are ours to use rightly, we may lose the keen ability of judgment and the acquired knowledge of human nature which actual need developed mightily in our medical ancestors.

* * * * *

To-day, there devolves upon him who now addresses you the honor, much to be appreciated, of presenting the diverse aspects of an additional aid to our clinical insight into the alimentary tract. Many such have been devised for Man's greater power of diagnostic skill in this fascinating anatomical field: the esophagoscope, the transilluminating power of electricity, the chemical determination of the character of the gastric and enteric secretions, the study of the intestinal flora, the examination of the fecal constituents, *post defecationem*, the sigmoidoscope and the proctoscope. The application of each of these methods is well recognized as a step forward, but each is physically limited to that portion of the

alimentary tract wherein it is of greatest service. On the other hand, Roentgenology, apparently not yet content with her services to Medicine in other diagnostic fields, offers herself as a method applicable equally to the esophagus or the rectum, to the duodenum or the ileocecum. Any one will agree that the various meanderings of the alimentary canal, from the incisor teeth to the anal sphincter, constitute much food for scientific consideration, either anatomically or clinically. Accordingly, this structure can be claimed as a diagnostic stamping-ground equally by the medical man (in the narrow sense) or by the surgeon. Each has his own therapeutic function to perform. A diagnostic agent, to be efficiently used in every section or flexure of this canal must, therefore, be a broad one, and broadly to be presented and dealt with. It is meet, then, that such an exposition should be attempted before a gathering mixed as to its medical and its surgical training and practice.

No audience of the present year can fail to appreciate the fact that this subject, *per se*, is no longer a new one. Its growth and development have been so prodigious that, even after the few years of its life, we are prone to look back upon the earliest methods of its application as premature indeed. Without yet referring to the manner of to-day in the pursuance of a Roentgen examination of the alimentary canal, it may be merely interesting, in passing, to mention the pioneer attempts to determine the stomach's size, shape and position by means, for instance, of the shadow of a spiral wire inside a rubber tube inserted through the gullet; or by the generation of gas, likewise for observation by x-rays, within the stomach by means of the classical components of a Seidlitz powder separately swallowed. The only certain results, it would seem, of the latter procedure would be to make of one's patient an enemy for life! It may be supposed that little in the way of scientific result could be obtained by means of an indefinitely localized and comparatively un-

yielding, foreign body within the gastric viscus, or by the false limitations of the same organ inflated out of all semblance to its true size and shape.

Only such experiments as these, however, could introduce an entering wedge for the employment of a foreign substance so constituted, first, that it could be mixed, as if cognate, with the material given as food and therefore becoming in itself a component part of this food; and, second, that it had the power of absorbing x-rays to the extent that its presence could be seen easily on any record made by the physical effect of x-rays upon a fluorescent material or upon a photographic emulsion. Such a substance was fulfilled in the metal bismuth, the salts of which came to be recognized as the one substance of sufficient atomic weight to resist the passage of x-rays and thus to be opaque to them, and, at the same time, sufficiently inert to be given with food in the large quantities necessary for this purpose. Williams¹ reports the use of bismuth by him in 1898 and in May of that year a report of some observations on "The Movements of the Stomach Studied by Means of the Roentgen Rays" was made by Professor Cannon² of the Harvard Medical School, at that time, a student in the School. This was but the first of a series of communications by this observer setting forth the results of his studies by the bismuth Roentgen method upon the physiology of digestion in some of the lower animals, chiefly the cat. It can be said, without qualification, that this work of Cannon's is the bed-rock foundation of all that is accomplished to-day by this method with respect to human alimentation. It is constantly referred to by all writers upon the subject. While it shall be similarly quoted to-day, as a matter of course, there falls upon the author of this communication the privilege proudly of referring to these researches as the monumental accomplishment of a class-mate and a friend. Cannon's pioneer efforts upon animals, besides quite inverting many theories as to the physiology

of gastric and intestinal digestion, acted as the best sort of stimulation to similar knowledge with respect to the human subject. Some sporadic observations, by means of the bismuth method, had been attempted prior to 1904, but it remained for Rieder,³ of Munich, to demonstrate what could really be done. This work was commensurate with his previous similar accomplishment with regard to Roentgen examinations of the thorax by means of momentary exposures upon plates, at a time when such a thing was considered nearly impossible. From Rieder, as well as Holzknecht⁴ of Vienna, have come the greater part of Europe's share of the literature of the alimentary tract considered from the viewpoint of the worker in the Roentgen laboratory. As a practical clinician, however, no one has been more active in calling to his aid the Roentgen rays, and no one has drawn more sound conclusions from his observations thereby, than Arthur Hertz⁵ of London. The greater part of Hertz's attention has been confined to the intestinal tract and he has contributed much upon the clinical subject of constipation. In our own country, many workers were filled with enthusiasm by the examples set by Rieder and Holzknecht, and chief among these who have added to the Roentgenology of this subject have been Hulst⁶ of Grand Rapids, Pfahler⁷ of Philadelphia, Cole⁸ of New York and Skinner⁹ of Kansas City. These men, to say nothing of others, have helped, each in his own way, to make gastrointestinal diagnosis by this means a matter upon which the greatest dependence could be placed. As in any other subject, it may be supposed that much has been written upon which dependence cannot be placed and also, we may not quite agree with many statements made by those who have every right to be adjudged authorities. Nevertheless, each observer is adding, little by little, to the sum total of our knowledge, for the footing up of which, it is to be hoped, the time will never come. He who is ready, or says he is ready, to strike a

grand total in the account-book of his activities, by the same act closes the record of his efficiency.

Before many attempts had been made to apply this method to the human gastrointestinal tract, the subnitrate salt of bismuth had been the one generally in use by experimenters, chiefly, it may be imagined, from its easy acquisition in the open market. It was early used by Cannon, and later by Roux and Balthazard ¹⁰ who were working at about the same period. Among investigators upon human subjects, however, tentative doses, for diagnostic purposes, brought forth results not so evenly favorable. "Rieder," reports Hertz, "found that an ounce could be administered without danger" but "Böhme ¹¹ gave an eighteen-months-old marasmic child 'several' grams by mouth and two doses later by rectum. Three hours after the second dose, the child was seized with pain and diarrhea; he became cyanosed and dyspneic and died in half an hour." Erich Meyer ¹² also reports a fatality from the same cause in 1898. Nowak and Gutig ¹³ mention a death in four hours after the exhibition of an ounce of the subnitrate of the salt by rectum. Worder, Sailer and Pancoast, ¹⁴ working at the Hospital of the University of Pennsylvania, report six cases in which alarming symptoms were observed, although without fatal ending. It was first thought, and so stated by early writers, that these untoward results were due to the presence of arsenic in an impure sample of bismuth salt. The fatal cases, however, were known to result after a chemically pure bismuth had been given and the symptoms described in the earlier literature so closely simulated those of poisoning by the nitrites, that the observers at the University Hospital were led to believe that their cases were due to the toxic effects of the nitrites produced by the combined effect of the gastric hydrochloric acid upon the subnitrate and the action of the alkaline secretion of the intestine upon the residue, with the simultaneous production of oxycarbonate of bis-

muth and sodium nitrate, the latter being, however, converted into sodium nitrite.

In lieu of this deleterious salt, therefore, others have been offered as substitutes, and, as shown by the author before the Suffolk District Medical Society in 1909, none of them are wanting in ability to absorb x-rays to a sufficient degree. Of these substances, the more commonly used is, possibly, the subcarbonate which, although almost absolutely inert, is prone to affect the influence of the free acid in the stomach upon pyloric control, as Hertz asserts. Cannon has demonstrated that the question of acid pyloric control is an important one and his statements have been proven by clinical experiments in the human subject. We are strongly inclined to agree with Hertz to the extent that when the phenomenon of pyloric control is to be observed, we employ the oxychloride salt. Except for this, however, it is not especially needful. Unusually large doses of bismuth, given for diagnostic purposes, act, apparently, at cross-purposes to the classical physiologic influence of this drug, with the result that the alimentary movements scheduled by Roentgen rays are quite parallel with those in which the contents are unmixed with bismuth. This has been proven by Cook and Schlesinger,¹⁵ acting upon Hertz's suggestion. The vehicles used for the support of the bismuth salt in the digestive tract are as many and diverse in nature as can well be imagined, ranging all the way from the classical *wismuth-mehlbrei* of Rieder to the plain suspension of bismuth in water. We feel, however, that the ideal test meal, even if it be considered as merely a support, should be one containing a fair proportion of proteid and of carbohydrate constituents. We cannot expect to gain consistent observations from a stomach which attempts merely to eject material of an absolutely non-nutritious nature, nor, on the other hand, should we shoulder a supposedly abnormal stomach with a digestive task which we would fain demand of it in

health. Then, too, it is impossible to obtain any information with respect either to the normal capacity or the normal function of any digestive organ unless it is completely filled with the test meal. The amount of our information varies directly with the amount of food thus taken by the patient. These are matters, however, so manifestly technical, that they ill-become a communication endeavoring to deal with the clinical aspects of the subject in hand.

By his observations upon the movements of the stomach by means of x-rays, the account of which was published in 1898, Cannon established several facts. First, that it is a task practically impossible to form any correct conclusions as to gastric movements by the methods used prior to that time — by open incision and observation under atmospheric influences, by observations through open incision under salt-solution, or by the method employed by Beaumont through the gastric fistula of Alexis St. Martin. In the second place, Cannon proved that the appearance of the living stomach was quite at variance with its form and shape as previously known and taught and he also showed that there was much to be learned about the physiologic movements of digestion exhibited by the stomach toward which his initial investigations paved the way so materially. Cannon arrived at these fundamental conclusions, to say nothing of others, by means of the bismuth method upon cats, as has been stated, through observing the action of the gastrointestinal structures upon the fluorescent screen. This technical method, hereinafter to be termed the “screen” is now well known to nearly everyone and deserves no descriptive mention. Suffice it to say that, for purposes of study of the moving stomach and bowels, it has never been superseded and its persistent use by Cannon acted as the sole stimulation for fluoroscopy of the human alimentary tract as to-day pursued.

A detailed description of the physiologic digestive move-

ments of either stomach or intestine is unjustifiable here; first, because it would be but a poor repetition of the work already done and published by Cannon as to the lower animals and by Rieder with regard to the human subject; second, because no true exposition can be made of moving structures unless by the assistance of the fluorescent screen or by means of reliable Roentgen cinematographs, when these shall be made practically possible.

There are, however, one or two observations to be made with regard to the so-called anatomic stomach. Much discussion has been entered into by many European anatomists and Roentgenologists upon this question. Rieder's declaration that the preponderating diameter of the stomach is vertical, and therefore hook-shaped or siphon-shaped, was questioned by Holzknacht who, although he observed Rieder's form in eighty per cent of cases examined, denied that this form represented normality. His conclusion was, that the normal shape of the stomach is that of the gently-sloping cow's horn or steer's horn. Amid such variance of opinion, unquestionably authoritative, one is often at a loss as to which turn to take along the road of enlightenment; the writer's observations, however, have led him to the theory that, abnormality aside, the form of the digesting stomach is governed, to a great extent, by the quality and quantity of its nervous stimuli. He has repeatedly observed the occurrence of the cow's horn type of stomach in individuals who are normally of the so-called nervous diathesis in whom the pulse-rate and temperature is normally increased, and in whom nearly every function is affected positively by increased nervous stimulation. Cannon recognizes the great influence of nervous stimuli upon gastric function which he has proven experimentally. In such cases where the cow's horn type is to be observed will also be seen evidences of increased physiologic action, as exemplified in peristalsis. Cole of New York, observes, in the cow's horn

stomach, appearances corresponding to the six- or seven-cycle type of peristalsis (in accordance with his nomenclature); in other words, peristalsis which is extremely active. The writer's observations, however, led him not to agree with Cole as to the great rarity of this type of peristaltic function.

As an introduction, however, to our remarks upon the Roentgen pathology of the stomach, we may be justified in presenting a series of records obtained by momentary exposures to x-rays of strong and vigorous stomachs, and of another at, say, hourly intervals after the ingestion of the bismuth test breakfast.

The Roentgen pathology of the alimentary tract, by which may be indicated those pathological problems in this region, the diagnosis of which the Roentgen rays may help to elucidate, are composed of situations both simple and complex; the more simple diagnostic problems may relate to the determination of the size, the shape and the position of the stomach and to that of the position and arrangement of the classical divisions of the intestines. Problems which may be considered as slightly less simple are those having to do with the determination of motility, or other evidence of peristaltic activity. Those more complex in nature are problems dealing with the diagnosis of some localized influences inhibitory to normal function; to wit, kinks, pressure-points, and other hindrances due to extrinsic causes such as adhesion bands and the like. Finally, the often very complex problems which are offered by the intrinsic lesions, of a nature either destructive or cicatrizing, which are often malignant and always seriously to be considered.

Abnormalities in the stomach's size, shape and position are presented to us as diagnostic problems of the first degree and, therefore, may well be first considered. It has been the habit of many clinicians to speak of a stomach as "large" or "dilated" without making especial reference to

its shape, and, consequently, its position. As a matter of fact, the stomach is seldom to be called large, in the sense of an increase in all its dimensions; in fact, it varies so with the amount of its contents under normal conditions that he is daring indeed who would attempt to standardize its boundaries in all diameters. These simple cases are, of course, those which are not secondary to other conditions of more immediate importance such as carcinoma or ulcer cicatrix. They embrace the two great groups of splanchnoptotic abnormalities; on the one hand, those seen where the abnormal wall no longer gives the stomach, to say nothing of other organs, its proper support (a situation wherein multiple pregnancy might prove to be of distinct influence). On the other hand, the cases wherein subjective symptoms are more commonly noted, all the way from a very tangible complaint of localized abdominal pain, to the limitless ephemera of neurasthenia. Here must also be mentioned the instances where such conditions seem to be more or less distinctly the result of the misuse of costume, especially the corset, although increased general enlightenment in such matters has tended to temper the inexorable mandates of Fashion. As a matter of fact, the true corset deformity, applied to the position of the stomach and colon, is much less often seen now than heretofore.

It is almost impossible to describe any one form of splanchnoptosis as occurring independently, since it is so frequently the case that more than one organ can be embraced at once under Glénard's¹⁶ original classification. It has been the writer's experience that marked gastropptosis is seldom seen independently of the same tendency in the colon. There may be often an instance, on the other hand, where a very definite coloptosis may be unexpectedly seen in an intestinal canal receiving chyme from an energetic stomach, evidently normal in every way. In a consideration of these small abnormalities of size, shape and position of first, the stomach,

it is well, for the sake of time, to deal collectively with gastroptosis and gastrectasis.

Such stomachs, as they become filled with food, are seen upon the screen not to offer the muscular resistance to the entering mass which can so well be seen in a stomach with normal mural strength. Here, on the other hand, the organ fills more like the bag that it is, and, as the weight of the contained meal grows greater, there is increased evidence that the tone of the stomach wall cannot cope with it. What then happens? The bulk of the food-mass slides down to that part of the stomach which, being the most dependent, allows it to lodge. It has not been embraced in the pars media by any peristaltic indentations which normally should grow deeper and stronger as the pylorus is approached; or, if any peristalsis is evident, it is so weak that the pressure of the ever-increasing food-mass seems almost to overpower it.

As has been strongly suggested, and even put forward as the basis of argument, this heavy test-meal, composed, in part, of a metallic salt, would necessarily affect any stomach by its weight and bulk so that the appearance of ptosis may be falsely revealed. In answer, we may say that the weight of the average Rieder meal is close to two hundred and forty grams. This weight is not in excess, surely, of that of food consumed by a normal human being more than once a day! Moreover, we have already seen to-day how actively and efficiently the normal stomach attacks this meal of two hundred and forty grams. There is, apparently, no basis for such contention.

While a demonstration of these more simple conditions of the stomach is, by x-rays, determinable at a glance, they may present appearances at certain stages in the alimentary phenomena which are closely in accord with those seen in pathologic conditions of much greater moment. The most important, possibly, of these appearances is that of the evi-

dence of residue — residual bismuth remaining in the stomach after the lapse of an empirical interval allowing, say, six hours to elapse, as a fair interval of time in which the stomach may empty itself. We shall get the Roentgen evidence of residue in the following conditions based, of course, upon either a deficiency in the peristaltic driving-power or the presence of an inhibitive influence at the portal of exit — the pylorus:

- a. Esophageal delay (not constant).
- b. Gastropptosis with atony (not constant).
- c. Gastrectasis (not constant).
- d. Carcinoma pylori (constant).
- e. Gastric ulcer callous or cicatrizing (generally constant).
- f. Old ulcer in the lesser curvature of the pars media (generally constant).
- g. Old ulcer in the lesser curvature of the pars pylorica (generally constant).
- h. Old pyloric stenosis due to ulcer or carcinoma on an old ulcer base (constant).

Holzknicht, who has carefully classified these instances in which residue occurs and even tabulates the shape of the residue with regard to its pathological significance, says, that a residue, after six hours, points indubitably to an organic obstruction at the pylorus. In so far as his observations have as yet shown him, the writer cannot quite agree with this literal statement. He would qualify his disagreement, however, by saying that, in a case of a nature apparently atonic, a residue after six hours would lead him to be extremely circumspect as regards the pylorus and to seek further evidence as to its patency.

These gastric conditions of ptosis and ectasis, together with the same situations involving the large intestine, have become of much clinical importance during the past few years. The day is passed when nephropptosis was the most

important subdivision of the pathological complex described by Glénard, especially from the surgical point of view. There has been a great deal of therapeutic good already done both surgically and medically through the information obtained by the rational and intelligent employment of the Roentgen rays diagnostically in this subdivision of Glénard's disease.

There are here presented the records of a series of examinations in an individual in whom there is a moderate degree of static aberration in the shape and position of the stomach in which residue persists. Consequently, there is exemplified, in this case, the likelihood of residue in gastrectatic cases and the importance of its appreciation in such cases.

A young woman, who is the subject of such symptoms as lassitude, headache, debility, anemia, nervousness, etc. has been sent to a near-by sanitarium for what had been generally called obstinate nervous debility. After observation here for a few weeks, the conclusion was arrived at that she was suffering from the effects of a metabolic deficiency. Upon this, she was referred to the writer and the following exposures were made:

The stomach is moderately low and, while peristalsis is weak, the degree of ectasy cannot be called great. (Fig. 1.)

A second exposure, made one hour later, shows the slightly increasing tubular form of the median part of the stomach but evidence of only a slight amount of food ejected. (Fig. 2.)

An exposure, made two hours *post cartum*, shows a beginning evidence of ectasy involving the *pars pylorica* and *pars media*. Peristalsis at the preantral region, however, is not lost. (Fig. 3.)

The next exposure, made three hours after the meal, shows less food within the stomach but with active peristalsis at the pylorus only. (Fig. 4.)

The next exposure, five hours after the meal, shows the



FIG. 1



FIG. 2



FIG. 3



FIG. 4



FIG. 5



FIG. 6

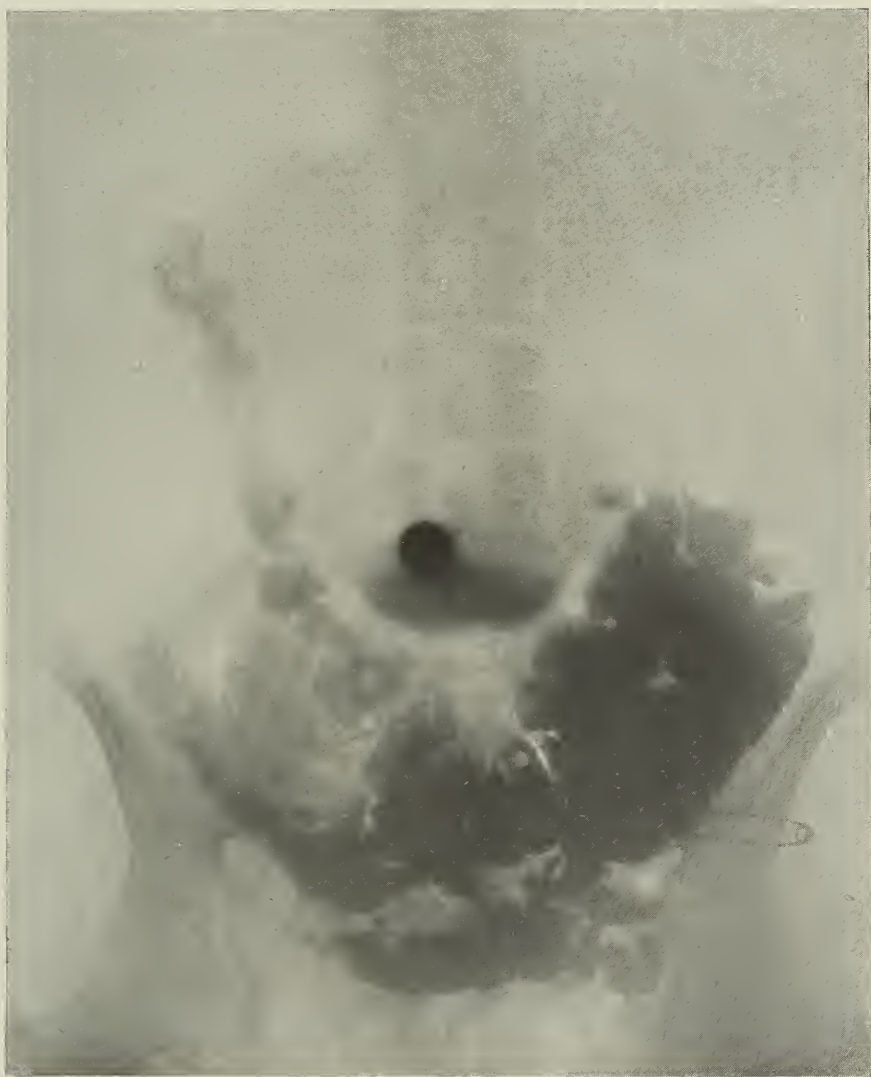


FIG. 7



FIG. 8

picture before you; residue still existing, but not, at this time, to an unreasonable degree. (Fig. 5.)

The next plate, six hours *post cartum*, shows the stomach definitely not yet emptied. (Fig. 6.)

Little change has taken place at the next exposure, nine hours after the meal. Definite residue still exists although the extreme anterior portion of the discharge-column is well within the large intestine. (Fig. 7.)

At last, twenty-four hours after the meal was given, the stomach is empty. This case illustrates what degree of stasis may exist where there is relatively so moderate ectasia. The clinical history and examination here offered no suspicion as to the presence of any pyloric narrowing, either ulcerative or malignant. (Fig. 8.)

* * * * *

After a consideration of the aberrations in shape and position, as well as in motility and general activity of the gastric viscus, our attention naturally turns towards the faithful "keeper of the gate" so frequently beset on all sides — the pylorus. As normal peristaltic activity increases as this portal is approached, in the same direction does gastric pathology increase in gravity and, consequently, in importance. Therefore, we enter upon our diagnostic problems of the third degree, but we are withal to bear in mind many phases of those with which we have already had to deal, for it is seldom that one is not interwoven with another. For instance, hyperperistalsis so often may warn us of pyloric spasm from organic cause as well as of simple visceral hyperstimulation. The Roentgenological observation of the evacuation of the chyme will settle the question. Or, conversely, the persistence of residuum is often concomitant with gastric atony and ectasy, as has been shown; on the other hand, it may be a sign-post pointing directly to a stenotic pyloric path, as will be shown.

There is no condition more than those involving the gas-

tric pylorus or the duodenum wherein the x-rays are to be considered no more than a factor in diagnosis, an appellation which the title of this communication endeavors to emphasize. Without knowledge of physical findings by other technical means, the Roentgenologist is disabled, if not helpless. There is a Roentgen laboratory in this country where a routine chemical examination of the visceral contents is made in stomach cases. It is not in any way intended to filch the thunder of the internist or the medical chemist, but it is believed, merely, that many cases of organic importance sometimes of necessity lack this added information.

From what we have seen already, it will be realized how important is the bearing of proven gastrectasis or gastropptosis upon the mooted clinical question of autointoxication. Even more important, however, promises to be that of the confirmation, by x-rays, of intrinsic organic disease of the alimentary tract. This advance has been stimulated by the work of Holzknecht of Vienna and he has been ably assisted by Haudek,¹⁷ who has come upon an ingenious method of examining the stomach and colon simultaneously by x-rays, and by Jonas,¹⁸ who has discovered the Roentgenological evidence of gastric antiperistalsis. Like all pioneers, Holzknecht has drawn some forceful conclusions, which, to the ultraconservative may contain the essence of radicalism were Holzknecht's position in the Roentgenologic field less stable. To rehearse his conclusions, already published, would be to deprive this communication of any claim to originality. Suffice it to say that Holzknecht arrives at a diagnostic decision by means of Roentgen rays in combination with certain indubitable evidence obtained by chemical examination and intelligent manual palpation in the following:

Carcinoma pylori.

Carcinoma without stenosis (inoperable or operable).

Simple gastric ulcer.

Old contracting ulcer either at the pylorus, in the pyloric portion or in the medial portion.

Carcinoma on the base of an old ulcer with or without stenosis.

Carcinoma of the cardiac portion, and

Ulcer duodeni.

The use of manual palpation in such instances is not for obtaining objective evidence of visceral limitations which the x-ray examination itself obtains indubitably, but for localizing sensitive pressure-points through the patient's sensorium.

Anyone who has done much in alimentary Roentgen diagnosis will recognize the worth and stability of Holzkecht's contribution; he who has done but little, may require the further enlightenment which added experience will furnish.

It is the writer's set purpose to present only a few examples of the value of Roentgen examinations in such cases:

A young woman, a domestic, presents a history of many attacks of epigastric pain, of an increasing inability to digest and has, on two occasions, vomited a small quantity of blood, which she thinks may have been no more than gastric contents tinged with blood. She has been irregular in her habits of eating, and, through her recent inability to digest much food without painful symptoms, has lost considerable weight. On screen examination, she presents a large, but peristaltically active, stomach, from the pylorus of which, at a period of ten minutes after the meal, no food has escaped.

Three hours after the meal, the situation is as shown. Peristaltic activity has not greatly diminished. The pre-antral portion is distended. The antral portion itself is contracted. There is a narrow isthmus through which the food has to pass.

At the next exposure, made at a six hour interval after the meal, the situation is clearly shown. In addition to the residue present, there is a considerable ptosis of the stomach

which may, in itself, account for some of the residue. According to Holz knecht, however, it does not. The anterior discharge column is seen to occupy the transverse colon, the splenic aspect of which is, in itself, pushed down by the low position of the stomach.

Another exposure, made at nine hours, shows but little change, residue remaining. The head of the discharge column has made but little advance, which may be due to the aforementioned pressure on its splenic aspect by the low stomach.

In twenty-four hours the stomach is seen to be empty, or is again filled with food not bismuthized and, therefore, invisible, but its position is shown by the aberrant course of the transverse colon. The head of the discharge column occupies the sigmoid and rectum.

Diagnosis: Cicatrizing and stenosing ulcer at the antral portion of the stomach.

A lady, aged fifty-six, has also suffered much with epigastric pain; is greatly troubled with gastric and enteric flatus; has feelings as if a cord were drawn tightly around the subphrenic region; has lost a prodigious amount of flesh; is cachectic, and has had multiple attacks of vomiting in which the vomitus is somewhat unusual in color. On presenting herself at the laboratory, she readily eats a full bismuth meal and immediately after a screen examination, an exposure is made with the following result:

It is fortunate, as will be seen, that she so readily ate the full meal, for, even so, it only partially fills the enormous stomach which you see before you. By actual measurement of shadow, the length of this stomach from its capital to its caudal pole is 41 centimeters. Please, however, note the fact that, in spite of the great amount of ectasis as seen here, there is a distinctly visible effort at peristalsis, the waves of which are marked by arrows. This immediately leads us to be on our diagnostic guard.



FIG. 9



FIG. 10



FIG. 11



FIG. 12

A second plate, made a few moments later, shows the effort of the peristaltic action at pressing the food into the preantral region. (Fig. 9.)

A third exposure, made almost four hours later, shows an amount of residue which would amply fill a stomach of normal size. Peristalsis still persistent; but there is but a suggestion of food beyond the pylorus. (Fig. 10.)

Six hours later, still much residue. Peristalsis strong. The indentation forming the sphincter antri is deep. The antrum itself is greatly distended and is filled by virtue of this distention, except at its immediate prepyloric portion. What prevents its distention here? (Fig. 11.)

The next slide shows the same stomach nine hours *post cartum*. Still an enormous residue. What, however, has escaped the pylorus has been carried along into the cecum, which is marked by the letter C; not enough, however, to anywhere near fill this portion of the large intestine. (Fig. 12.)

In twenty-four hours. Still no inconsiderable amount of residue. A sporadic amount is in the large intestine at the ascending colon. This is the last of the series in this case, which was diagnosed as carcinoma of the pylorus.

A young man presenting the picture of starvation has had for some years an increasing tendency to eructate a large portion of all swallowed food. There is a history of an old gastric ulcer. He presents himself for Roentgen examination and a bismuth mass is fed to him slowly. Soon after each swallow a gurgling sound is heard as of water running through the outlet of a sink. His diagnostic plate presents an area of constriction which lies within the cardia through which the food passes, but with difficulty. Upon operation, the mucosa of the gastric cardia was found to be extensively cicatrized and thickened so as to allow the passage of food through but a narrow canal, as the slide portrays.

A man of about twenty-eight years complains of symptoms

which, to his physician, closely simulate gastric crises, especially since there is a luetic history. Being unable to swallow a bismuth meal of any consistency, a thin butter-milk suspension was given him in lieu of this. An exposure was immediately made of the condition found. The entire pre-antral portion of the stomach is the seat of a stenosis which obtains in the distal direction until the pylorus is reached. This is one of the most interesting of the so-called hour-glass types that it has been the fortune of the writer to see. Soon after this examination, the patient was operated, upon the strength of the findings as here shown. The surgeon, Dr. Jones, reports that he could pass his little finger through this stenotic canal and the feel of the gastric wall gave the impression of its being of a consistency similar to chamois skin. The stenotic portion was thereupon excised and the patient is now relieved of his symptoms and is improved as to his nutrition.

A middle aged gentleman, well known in local public life, presents, briefly, a history of loss of flesh, of increased weakness, of much gastric pain of a griping nature and of vomiting. His stomach presents this picture. Its shape is distinctly that of a horn. The normal contour about the prepyloric region is lost and the peristalsis is violent. There is no chemical evidence of hydrochloric acid.

In six hours the residue remaining is distinctly affected by the persistent peristalsis, the waves of which are marked by numbers.

Diagnosis: Carcinoma of the pylorus and prepyloric region. Proven at autopsy.

Once having escaped the pylorus, the physiologic disposition of the chyme is by no means a closed book to the Roentgenologist, as the anatomic arrangement of the small intestine might lead one to assume. The first segment of the duodenum is, of this division of the intestinal canal, the most likely to offer information with regard to its condition.

This is apparently because the screen examination indicates that the duodenum acts as a temporary reservoir for the chyme. The bismuth-loaded gastric ejections are, with the greatest frequency, seen to be delayed at this point in the "caput duodeni," before passing onward with increased rapidity. Upon the recognition of the fact that the first portion of the duodenum, thus seen to act as a reservoir as does the stomach at its capital pole, Skinner applies the technique of gastric fluoroscopy to this portion of the intestinal canal. To this segment of the duodenum, Holzknecht gives a refinement of physiologic function by calling it the "*Püfferraum*," or "teasing-room." Beyond the duodenojejunal angle and, in fact, beyond the first portion of the duodenum, physiologic action is hard to follow by reason of the relatively great speed of the intestinal action and the anatomical disposition of the gut. The Roentgenology of the human small intestine, however, has proven the theory of its segmentation as set forth by Cannon, and this segmental activity can be to-day recorded in spite of the vaunted motility of this portion of the gut. Segmentation in the duodenum is almost constantly to be observed beyond the spade-shaped shadow of the first portion, in the shape of button-like masses which are lost among one another as activity increases in the second and remaining portion.

The speed of motion in the discharging column in the jejunum and ileum can be estimated by the promptitude, or otherwise, of the appearance of the food-mass at the ileocecal valve. This appearance will average, according to Hertz, four and three-eighths hours after the food has been taken. Our observations in non-pathological situations average slightly less than this, using, withal, a food-mass of the same chemical constituency as used by Hertz. The chemical nature of the test meal has a distinct bearing on the acid control of the pylorus. The promptitude with which

the filling of the small intestine takes place from an unobstructed pylorus is really surprising and the fact has an immediate technical bearing in the Roentgen laboratory.

Immediately the ileocecal valve is passed the change which takes place in the action of the bismuthized chyme is nothing less than startling. The cecum and ascending colon will gradually fill, but, when apparently full to slight distention, will show, for a time, little inclination to pass the food onward. The stimulation to action caused by the presence of the food results in the production, among others, of antiperistaltic contractions. Intestinal antiperistalsis was suddenly come upon by Jacoby,¹⁹ about five years before the discovery of Roentgen rays, and since has been localized in the proximal colon of the cat by Cannon in connection with his aforementioned investigations. The likelihood of the existence of physiological antiperistalsis in Man has been the cause of endless discussion. It is hard to see, when the action of the chyme is observed well within the human proximal colon, how the presence of antiperistalsis can be doubted even if such actual waves were not seen. No other force, it is believed, could produce the appearances which are to be observed in the cecum as the food is crowded back and squeezed against the walls of the blind gut. Antiperistalsis may occur elsewhere in abnormal conditions, but, of itself, is never pathological. Rather, as Rieder says, it is the pathologic manifestation of an accentuated physiologic function.

The advancement of the chyme in the colon is brought about by (1) peristalsis by haustral segmentation, the evidences of which are so often seen and easily recorded by x-rays, and (2) by the "great peristaltic movement" (as opposed to segmentation) by means of which the food-mass is transferred, by a series of infrequent jerks or shifts, *en masse* from one portion of the colon to another, which Holzknecht's screen examinations have enabled him to

observe, but which are extremely hard to see in any other way. Finally (3) the discharge column is advanced by oscillating or pendulum movements, of great and small types. The great oscillations may be better described as windings or writhings, produced, perhaps, by intrinsic intestinal movements in opposite directions towards a common centre. These, likewise, can be recorded upon plates by the influence of x-rays. The smaller oscillations are to be seen on the screen as influencing the shape of the food-mass impinging upon the haustral contractions and, therefore, indicating the character of their intrinsic movements.

A meagre description merely of the gastric and intestinal physiological activities, as thus to be observed, would be inexcusable even by a tolerant audience, were it not for the fact that a mention of the normal is necessary to a proper mental conception of what may be considered as aberrations from it. Especially with respect to the intestinal canal is the dividing line between aberrations in structure or function and normality itself a most pliable one. Repeatedly has a certain section of the course of the large intestine been diagnosticated as the seat of a kink, pathologically induced, when, in reality, the exposure to x-rays was made at just the time when that portion of the gut was undergoing one of its oscillatory or writhing movements. Intestinal abnormality certainly exists in instances a-plenty without the necessity of adding to the number its innocent physiologic acts.

Finally, on account of the loose mesenteric attachments of both intestines, these organs are especially prone to untoward influences of a nature which tend to divert their courses and to thwart their functions in localized areas. We are to-day familiar with the ptoses and what-not which are to be enumerated under Glénard's classification. Evidences of these are thus demonstrated. We have also learned, through the observations of Mr. Arbuthnot Lane,²⁰ with the assistance of Dr. Jordan, of the presence of aberrations

tions in arrangement involving the distal portion of the ileum as it approaches Bauhin's valve. Disturbances such as these are oftentimes brought about by nature herself as a part of the general mischief she creates with her so-called intestinal adhesions. Naturally, therefore, we may many times look for such aberrations in the immediate vicinity of the appendix vermiformis.

Any suggestion of disease involving the intestinal canal and the likelihood of helpful investigation thereof, particularly where the abnormality is suspected to be of an intrinsic character, suggested one more Roentgenological step. This procedure involves the injection of the bismuth by rectum instead of its ingestion by the mouth. Examinations such as these wherein the bismuth is supported by some such mass as the *bolus alba* of the Germans have been extensively pursued by Haenisch²¹ of Hamburg. Haenisch tells the writer that he is so impressed by the efficiency of this mode of test meal administration that he employs it in nearly all his intestinal cases. The method, however, certainly cannot be of prime value where the determination of intestinal aberration depends upon an observation of whatever of physiology it has to offer. Its chief value lies in the facilities it offers for fluoroscopic observation in situations which may be beyond the reach of the proctoscope or the sigmoidoscope.

Any mention of the Roentgen method as applied to the esophagus has been purposely left until now as advancement of technique has not been so rapid in this region as in other portions of the tract. The chief value of Roentgen examinations here, and it certainly is a dependable method of observation, is the determination of the situation in cases presenting symptoms of so-called cardiospasm. Esophageal diverticula, to say nothing of organic stricture, are usually of ready Roentgenological application in the inverse order of their mention.

In recapitulation, it may be said that we have to-day, in the alimentary application of x-rays, as dependable a method of aiding our diagnostic knowledge as has been given us for many years. Nevertheless, the writer considers the mission of this paper as fulfilled to the utmost if he shall succeed in conveying the impression that, in this method, we have but a factor making for our diagnostic success in any given case. As was stated at the beginning, the practitioner of the future is in danger, through just such helpful agents as these, of becoming a clinical scientist instead of a scientific clinician. His primary mission is still entered upon at the bedside and at the bedside he has little else to aid him than had his predecessors of the earlier days — his five wits. Let him, therefore, use them, and then he shall be able to stretch forth his hand toward the laboratory, not beseechingly, as one who is helpless, but with the authority born of knowledge, as becomes a master.

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DISCUSSION OF THE THREE PRECEDING PAPERS.

DR. S. J. MIXTER, Boston: In all the comparatively new subjects that have come up in surgical literature and practice of late years, this question of intestinal malformations is one of the most important, if not the most important.

Intestinal malformations, whether acquired or hereditary, (and the two are so closely combined, so closely connected that it is impossible to speak of one and not the other) are very common. We first became acquainted with these things from the study of adhesions. Every man who does abdominal surgery is constantly running across cases that puzzle him, not only during the operation but during the convalescence. Sometimes we find adhesions so dense, so extensive, that it is almost impossible to get at the object sought in the abdomen, and yet there is no history of trouble either previously or afterward. In other cases we find no reason for symptoms, and it is only as we look back after having had some experience that we know that it must have been due to some congenital or acquired malformation, apparently slight, but sufficient to cause the result.

Why adhesions form in certain cases and not in others has not yet been satisfactorily explained. Every surgeon knows that in some cases, where after a laparotomy the convalescence has been uneventful, a subsequent opening of the abdominal cavity may show extensive adhesions, and he also knows that after a diffuse peritonitis he may find almost no adhesions. How to prevent the formation of adhesions in a clean abdomen and how to prevent their re-formation when we

divide those already formed is the problem that confronts us. Many surgeons refuse to operate for the relief of adhesions as they expect them to re-form, but I have opened the abdomen after most extensive division of adhesions and found no re-formation and a perfectly smooth peritoneum — though unfortunately this is not always the case. An important point in the operations for the cure of these conditions, both congenital and acquired, is that when we open the abdomen we are not able to say which one of perhaps several or many abnormal conditions seen is the cause of the symptoms demanding operation. This leads to an unnecessarily prolonged and severe operation. Could we put our finger on any one or two kinks or adhesions and say surely "This is it" the operation would be very simple.

When you come to these congenital malformations (if we can really call them malformations — for I am beginning to think the normal place for the stomach is in the pelvis, we see so many cases) when you do find what you think is abnormality, then you begin to consider. This man divides adhesions or internal bands, another man makes more adhesions and sews up, another man does the hammock operation, another man excises, etc. Of all these different things each one has its use, but the trouble — the reason that we fail — is because we do not recognize the condition that we are facing, if by chance we do appreciate the condition, we do not discover the means that we must use to correct it. In other words, we cannot make a diagnosis after we have got the belly open.

I am glad that Dr. Ransohoff mentioned the short incision for appendectomy. It seems to me absolutely wrong unless there is some special reason. The hammock operation is certainly a most valuable one in certain cases, but it fails in others.

A short time ago I removed from a friend, a young woman, about two-thirds perhaps of the colon. Starting at the cecum I left the cecum and took out the colon until I reached the middle of the transverse colon. It was then very easy to make a lateral anastomosis, and the patient has been well, and there has apparently been a good effect on not only the constipation, but also on the stomach symptoms. Now that intestine I took out was certainly five times as thick as

it ought to be, and Dr. Whitney reported that the mucous membrane was eroded on the cecal end. If I had known this I should have taken out the cecum too. That piece of intestine must have weighed a pound or two. It was so heavy that it dragged the stomach down, and getting rid of it gave relief. Perhaps the hammock operation would have held it, but I doubt it.

I do not believe in the Lane's operation, but I am willing to be convinced, although I should hesitate about performing it. I do not believe much in sidetracking large parts of the large intestine. There have been a good many instances of the formation of fecal stones in such cases.

We must remember that in this whole subject we have not yet obtained final results, and will not for two, three, four or five years.

Mr. Chairman, I think we are especially honored in having a paper such as that which Dr. Ransohoff has given us. To come from a distance and give us a masterly paper, the work of a master mind, deserves our sincerest thanks.

DR. J. E. GOLDTHWAIT, Boston: A discussion such as this is most timely, since it is becoming constantly more evident that in the better understanding of the formation, position and physiological function of the viscera is to be found the solution of many of the problems of acute and chronic medicine.

To have a proper understanding of the subject it should be realized that apparently one of the penalties which the human family pays for being the highest type of mammal is that in assuming the erect posture, downward displacement of the abdominal organs is inevitable, and that unless this were offset by some other element it would naturally lead to the extinction of the race. It is perhaps for this purpose, as much as any other, that the human family was endowed with those attributes commonly spoken of as intelligence.

Abdominal visceroptosis in itself is apparently of little importance, since probably every human being, after the period of life as the quadruped, commonly spoken of as infancy, has passed has more or less of this condition. The

degree in itself is of little importance but amount of interference with the visceral function is the element of real importance. To understand the possibilities of interference with the function it must be understood in the first place that the size and shape of the abdominal viscera have wide variation, and also that the supports for the organs upon which their position and consequent function must depend also vary greatly. The effects which these peculiarities of formation may have upon the function of the special organs are at once more or less evident, but their full significance cannot be appreciated unless the body is considered as a whole and the effect of each organ or part is studied in its relation to the other parts. For instance, the extreme ptosis of the stomach may be of little consequence as far as the stomach itself is concerned, but it may cause serious pressure upon or interference with some other organ, and treatment of the special organ will result in little benefit until the pressure of the displaced stomach is removed.

To understand the problem fully it seems to me essential that we remember that the person who is anatomically normal in all his parts may be assuming faulty postures so interfere with the organs as to cause serious harm. In any droop of the body, the chest is flattened, which means that the ribs move downward in their anterior portions, and in this movement, since the ribs are attached to the spine at the back, with the attachment higher than the sternal end, in the downward movement, the anterior portion must be drawn backward as well as downward. This naturally lowers the diaphragm and narrows the space (anterioposteriorly) in the upper abdomen, so that the liver and stomach must be forced downward. Not only this, but since in this position the abdominal wall is relaxed the natural anterior support is lost so that all of the organs sag forward in varying degrees. Treatment of symptoms which may result from the interference with a special organ without considering the real cause of the difficulty is obviously of little purpose.

It should also be understood that not only may these effects of posture exist, but that many individuals have peculiarities of formation which very much increase their potentiality to trouble. In the development of the embryo many imperfections may occur. The stomach may remain

as the small, cylindrical shaped organ with loose mesenteric attachments, the so-called congenital type. The duodenum may be more mobile than normal. The jejunum and ileum may not only have longer mesenteric attachments than normal, but may vary greatly in their length. In several subjects examined not more than half the total length of the small intestine was present, with naturally much evidence of malnutrition in these individuals. The large intestine may vary much in length, while the mobility may vary from that which exists with a free mesentery upon its entire length, to that which would exist if it were normally attached. The liver has a much greater range of motion and possible displacement than is often supposed, frequently sagging below the crest of the ilium. The mobility of the kidneys at times is fully known.

All of these and many other conditions may exist in the abdomen and the special feature or any combination of these conditions may produce symptoms which at times are of importance.

If all of these features are recognized, it at once becomes obvious that to simply treat gallstones without correcting the mechanical or anatomic conditions which may have led to the interference with the normal function of the liver or gall bladder must lead to ultimate results which are unsatisfactory. The same thing is true of many of the conditions of dyspepsia, which are obviously imperfectly treated, if the treatment consists simply in medicines without attempting to correct the anatomic or mechanical conditions which are interfering with the function of the organ. This is also true in the treatment of disease of the kidney, which may be due to the maladjustment of the kidney itself or some other organ, which makes the normal kidney function impossible. A similar condition exists in the treatment of the pelvic organs, it being obviously unsatisfactory to simply correct the position of the pelvic organs without correcting the position of the other organs, which is frequently responsible for the malposition of the pelvic organs. It is obviously unwise to operate upon any one given organ without considering its relation with the others, so that if one organ is sutured in place, such as the colon or stomach, without considering the relation of that organ to the others, it is obvious that

the condition of the patient may be worse than it was before, since a fixed point is produced in place of the mobile point to which Nature had been able to more or less satisfactorily adjust herself before the operation.

My particular part in the discussion is to urge the profession that in the treatment of such conditions a careful study of all the parts be made and that the treatment may not be discontinued until the whole body can be used with the least possible interference with the function of its many parts. By so doing not only will the individual benefit, but it seems not improbable that the correction of such anatomic defects will result in benefit which will show in subsequent generations.

DR. W. P. GRAVES, Boston: The study of the class of cases under discussion convinces one of the extreme complexity of the subject. Although all these cases present common symptoms of autointoxication it is evident that there are many different types of abdominal lesions, and numerous different etiological factors which may bring about this group of symptoms.

Owing to the present vague knowledge of the subject there has been, so far as I am aware, no very satisfactory classification of the diseases which are loosely grouped under the head of enteroptosis and abdominal adhesions. For lack of such a scientific classification I have been accustomed to divide the cases which I see into three different types.

The first is the type of nulliparous or unmarried woman in whom the condition of gastropotosis or general enteroptosis is predominant without any particular evidence of inflammatory obstructing adhesive bands. These patients correspond to the class which Rovsing terms the virginal type of enteroptosis. These patients nearly invariably have postural deformities, all of them have a prolapsed right kidney, and many of them have misplacements of the pelvic organs. The nervous and digestive symptoms are characteristic and very familiar.

The second group corresponds to what Rovsing calls the maternal type. In these women the visceral ptosis is a result of childbearing and is associated with diastasis of

the recti muscles and consequent relaxation of the abdominal wall. Prolapse of the pelvic organs and vaginal relaxation are always present. The symptoms in these cases are less those of autointoxication and more those of mechanical dragging, namely pain in the back and loins, bearing down sensations in the pelvis, and general tire and exhaustion. Autointoxication symptoms are also present.

The third group of cases comprises those who have distinct obstructive adhesive bands usually associated with the large intestine. These patients may or may not have enteroptosis, and may or may not have structural deformities. It is not difficult to distinguish these cases from the other two groups even without the aid of the x-ray. The x-ray is, however, of great importance.

The following is my personal experience in treating these three groups of cases.

With the first group, namely, the virginal type of enteroptosis without marked adhesions, I have been extremely conservative. The various operations of suspending the stomach and the large intestine, or removal of the colon, or the various procedures of intestinal anastomosis have not appealed strongly to my surgical instinct. I have been accustomed to refer most of these patients to the orthopedist, internist or the neurologist, according as the symptoms chiefly indicate. Suspension of the kidney I have resorted to only in rare instances, while gynecological operations of the pelvic organs I have regarded as unsatisfactory, excepting where indications for operation are very distinct. One of these indications has been in those cases which suffer from what I am accustomed to term gravitation ante flexion, where the uterus has sagged toward the sacral fossa, the fundus being still held forward by the round ligaments. In these cases there is a condition of extreme ante flexion with resulting dysmenorrhea. The operation of anterior fixation which fixes the uterus to the anterior abdominal wall and completely reduces the ante flexion has given satisfactory results in curing or relieving the dysmenorrhea which serves as an aggravation of the other nervous symptoms to which these unfortunate patients are subject.

The second group of cases, namely, the maternal type of ptosis due to childbirth is distinctly surgical. The operation

consists of a repair of the relaxed vaginal outlet, combined with some proper operation for supporting the pelvic organs. In addition to this an operation for the complete union of the separated recti muscles is performed, that restores the abdominal wall to its original firmness and tonicity, and serves to keep the intestines in their proper position. This group of cases is found chiefly in working women of the poorer classes. The reconstruction and restoration to efficient health of these forlorn patients is one of the most interesting and satisfactory departments of gynecological surgery.

Group three comprises those cases in whom the predominating features are the presence of obstructive adhesions with pericolitis. Many of these cases have a history of definite inflammatory attacks, a certain number of them dating from typhoid fever.

I am accustomed in these cases to dissect the adhesions and to cover over the denuded peritoneum as carefully as possible. The operative results in these cases have been very encouraging.

In a series of 492 abdominal operations performed during the past eighteen months in which I have made in each case a special search for evidences of pericolitis I have found definite adhesions of the colon in 49 cases or 10 per cent, where the adhesions were entirely independent of appendicitis, cholecystitis, salpingitis or ulceration of the stomach or duodenum. In 17 of these 49 cases there was nothing in the history or symptomatology to indicate colitis. In 11 cases a diagnosis of colitis was made beforehand and the operation was performed specially for the adhesions. In 32 cases the history showed constipation, intestinal indigestion and general nervous symptoms resulting from autointoxication. The following 4 cases are selected as especially typical.

Case 1. A woman of 49 had had mucous colitis and all its attending symptoms for two years. She had never had a normal movement of the bowels during that time, and had been treated constantly with rectal irrigation. X-ray pictures of the colon by Dr. Percy Brown indicated adhesions of the hepatic flexure. Operation disclosed a powerful Jackson's membrane much thickened at the hepatic flexure, and partially obstructing the bowel. All adhesions were dissected

away and the raw surfaces of the peritoneum were carefully closed.

This patient made immediate improvement in all her symptoms and reported at the end of six months that she was perfectly well in every way, her bowels having moved normally ever since leaving the hospital.

Case 2. An unmarried girl of 33 had been a semiinvalid for fifteen years following a mild attack of typhoid fever. This patient had consulted nearly every conceivable kind of medical specialist. She had had an orthopedic and a gynecological operation performed. She had no postural deformity, and was of good development. The symptoms were definitely characteristic of obstructive intestinal adhesions, with localized pain, especially in the left hypochondrium, great dilatation of the large intestine, and intense myalgic pains especially of the trapezius muscles.

An operation was performed and immense obstructing adhesions were found chiefly at the hepatic flexure. There were also adhesions about the cecum and the sigmoid. All the adhesions were carefully dissected and raw surfaces covered over. The patient made a somewhat stormy convalescence from this long and difficult operation, but finally recovered entirely as to her intestinal functions, and there was complete disappearance of local pain, and constipation. Treatment by an eminent neurologist for the habit neuroses which these patients invariably acquire has completely restored this patient to health.

Case 3. A woman of 39 had suffered with pain in the lower abdomen, legs, back, head and neck for thirteen years. She had been bedridden most of that time, and had not walked at all for eight years. She had had two operations performed during this time, one the removal of the ovaries with ventral fixation, and the other the removal of the appendix. This woman had been regarded as a complete and hopeless neurasthenic.

A diagnosis of intestinal adhesions was made and operation substantiated the diagnosis. The adhesions were extremely extensive, especially along the ascending colon. The adhesions were dissected and the raw surfaces covered over. The patient was completely relieved of her abdominal pain and was able to be up and walk at about the usual time

after the operation. Six months after the operation the patient reported as being well and able to walk and do her work.

Case 4. The following case illustrates the possibility of nonoperative cure of membranous colitis.

A woman of 40 consulted me for recent uterine bleeding, and was found to have multiple uterine fibroids. She had been in perfect health for five years. Two years previous to that time she had suffered from severe pain on the right side and was supposed for a time to have had appendicitis. A movable kidney however was discovered and it was decided that her troubles were due to the kidney. The most expert medical and orthopedic treatment that could be had was directed toward reducing the prolapse of the kidney. She was treated for two years, during which time she said she suffered from nervous prostration. At the end of two years she was entirely cured, having been told that the cure was due to the fact that the kidney had been permanently replaced. I found on examination that the kidney prolapsed easily to the same point to which the patient indicated it had prolapsed at the time of her two years' illness. The patient was operated on for her fibroid uterus and during the operation the right side was investigated. The kidney was extremely movable. I found, however, a typical well-marked Jacksonian membrane which extended from the cecum to the liver.

From the symptoms described by this patient I am convinced that she had five years previously suffered from a membranous pericolicitis, and that the medical and orthopedic treatment which had been directed with the purpose of restoring a prolapsed kidney was in reality an excellent treatment for the pericolicitis from which she was actually suffering, and that a symptomatic cure was thus effected.

ARTICLE XI.

NEUROLOGICAL ASPECTS OF INJURIES TO
THE CRANIUM AND SPINAL COLUMN.

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NEUROLOGICAL ASPECTS OF INJURIES TO THE CRANIUM AND SPINAL COLUMN.

INJURIES to the skull and spinal column derive their significance from their effect upon the nerve structures beneath. A discussion of such injuries from the neurological standpoint, therefore demands, in the first place, a diagnosis of the degree and kind of injury which the brain or cord sustains; and, in the second place, a determination of the means for its alleviation. This paper is more particularly concerned with the first of these propositions. For the sake of clearness it is well to consider injuries of the brain and injuries of the cord separately, since the problems involved are essentially different, from the point of view both of structure and function.

INJURIES TO THE CRANIUM.

As suggested above, an injury to the skull is not to be estimated by the amount of damage done the bone, but rather by the degree of disturbance occasioned the nerve structures beneath. It is evident, for example, that a fracture of the skull with displacement of bone may be of far less import to the individual than a blow, leaving no external trace, but causing more or less destruction of the brain. In other words, apart from the largely mechanical question of surgical treatment, what happens to the brain or the cord, as may be the case, is of vital importance, and this, if it be desirable to make such distinctions, is a neurological matter. The question of the diagnosis of the extent and character of the brain injury is, therefore, of immediate practical concern, and usually must be determined with

reasonable haste, if the best good of the patient is to be subserved. Speaking generally, the violence of the blow and its location are of importance in determining the extent of the brain injury. Other things being equal, naturally the harder the blow, the more damage is likely to result, both to the skull and underlying brain, although this is by no means a necessary consequence, since the location of the impact necessarily modifies its result. A very violent blow on the resistant vault of the skull is, for example, much less likely to lead to serious consequences than a decidedly lighter one at a point where the skull is thin, for example, in the temporal region; or at a more vital area, as the region of the oblongata. Regarded from the neurological standpoint injuries to the skull may properly be classified in relation, first, to the immediate general effect upon the brain; and, secondly, in relation to the subsequent or permanent damage resulting to the organ as a whole or to any of its parts. As in a consideration of all disturbances of the brain, it is well to keep sharply in mind the distinction between general and focal symptoms.

General Symptoms. Among the general symptoms on the part of the brain resulting from violence, disturbances of consciousness, broadly speaking, unquestionably take first place. Such disturbances may range from slight confusion to deep and irremediable coma. If the blow be relatively slight, the patient quickly recovers normal consciousness, usually accompanied by headache, vertigo, vomiting and pallor. If the blow be more severe, the pulse and respiration are not unlikely to show alteration; but it is undoubtedly true that too much stress should not be laid upon these phenomena even in conditions of deep coma. In still more severe injuries of the general sort now under consideration, the coma deepens, the pupils become unresponsive to light, the breathing is labored, the patient cannot be roused by any sort of pain stimulus and death results under condi-

tions of deepening unconsciousness. In the milder cases complete recovery not infrequently takes place, and this may even happen in cases of long-continued stupor. On the other hand, it should be borne in mind that even in instances of relatively slight apparent injury with transient disturbance of consciousness results of a more or less serious sort may persist for long periods of time. It should also be remembered that in certain instances of brain injury through violence, irrespective of hemorrhage from superficial arteries, the symptoms may be relatively slow in developing, and are undoubtedly in such instances to be attributed to the secondary results of edema rather than to the immediate violence of the impact. A brief report of certain illustrative cases will perhaps render these matters clearer than a didactic and detailed narration of symptoms.

A student of 18 of strong physique, while playing football, was struck on the back of the head. He did not fall, and continued playing. At the end of a few minutes he began to have headache and loss of strength, and, feeling that he was not doing justice to the game, asked to be relieved. He walked off the field with no special sense of discomfort beyond that mentioned. He at once went out of town, was nauseated and felt badly, but beyond a temporary undue emotionalism had no special disturbance of consciousness. He vomited more or less for a day or two; then gradually improved with returning appetite. A week after his apparently slight injury he attended the Yale-Harvard game, considering himself well. The excitement was considerable; he sat up rather late that night, and the following morning again felt ill, vomited, had much occipital and some frontal pain and was obliged to go to bed. Examination showed dilated pupils with retained light reaction, and normal fields and fundus. The pulse was 60; the heart was enlarged, owing no doubt to his previous strenuous exercise; the blood pressure was 125. There was no temperature or sign of focal disturbance. Vomiting persisted, the pulse went down to 46, and remained at that point for several days. Improvement was very gradual, but after complete rest, for the most part in bed, careful regulation of his diet, and avoidance of excitement of all sorts, his recovery was complete.

This case presents several somewhat unusual features. The original injury was slight to all appearances, and there can be little question that had rest been enforced from the

first, the relapse would not have taken place. The lesson such a case teaches is the desirability of insisting upon complete relaxation both of body and mind for a very considerable period even after apparently slight injuries to the head.*

A boy of 14 fell from a trapeze, striking his back and head. He lay still for a moment in a dazed mental state. He was able to get up in three or four minutes, walk into the house, talk naturally, but was evidently slightly confused. He was pale but otherwise showed no abnormality. He was soon able to walk nearly half a mile, but then complained of feeling sleepy, and lost his sense of orientation. He was brought home, still able to walk, but confused. He quickly developed a difficulty in walking, and increasing mental confusion. He evidently did not know what he was doing and, at the end of about two hours, became delirious, resistive and incoherent. He was violent, profane and difficult to control. From this state he sank into a stupor. When I saw him, about seven hours after his fall, he could be roused with difficulty, gave his name, made some intelligible remarks, but was dazed, confused, and frightened, without knowledge of what had happened to him. The physical examination showed no significant abnormality. His pulse was 78 and slightly irregular. Half an hour later, he recognized a friend and called him by name and, from that time on, steadily improved and recovered completely without further complication.

This case illustrates a somewhat more severe injury than the foregoing, and again emphasizes the lesson, difficult to learn, that even after comparatively slight injuries to the head, complete rest is demanded. Here again, it is at least possible that had the boy been put to bed, the somewhat alarming development of his symptoms might have been averted.

A girl of 25 was found lying in the road beneath a horse which she had been riding. There were slight abrasions on the side of the face and back of the hands, but no further evidence of injury. She was taken to a house in a semiconscious condition. At the end of a half hour, she vomited profusely, and sank into a stuporous state, from which, however, she could be roused. Further examination disclosed a slight and apparently painful hematoma behind the left ear, without discoverable fracture. The pulse on the day of the accident was 83; It steadily declined until on the third day it reached 52, remaining at this rate for eleven days. It then

* Krause: *Chirurgie des Gehirns und Rückenmarks*, Berlin, 1911, p. 630.

began to rise somewhat and, at the end of another week, was between 70 and 80. During all this period the patient remained deeply stuporous but developed no focal signs whatever. Recovery was ultimately complete.

The unusual feature of this case was the long continuance of an extremely slow pulse in spite of a gradual tendency toward improvement. This criterion of pressure is by no means constant and should not be given undue weight in prognosis.

These cases are all examples of the general symptoms resulting from head injuries of varying degrees of severity. None of them showed the slightest evidence of localized injury to the brain, and all three recovered completely without complications of any sort. This is the usual outcome in cases of this character, but the prognosis must always be regarded with doubt until consciousness is fully restored and the accompanying symptoms have subsided. In the first case, disturbance of consciousness played a subordinate role, and vomiting with slow pulse was the most persistent and annoying symptom. In the second a confusional mental state dominated the clinical picture; and in the third, together with a long-continued stupor, a persistent, slow pulse was the most striking sign. From these cases, selected as examples from a much larger group, it will be seen that a wide and often inexplicable variation of symptomatology is to be expected, and that no special prognostic importance should be given to any one sign in cases of this relatively mild type.

It is important to consider in this connection what happens to the brain under traumatism of this degree of severity. It may be said, without likelihood of contradiction, that the disturbance is primarily circulatory in character. The exact mechanism by which circulatory disorder is brought about, as the result of blows, is little understood and is not pertinent to this discussion. The term *concussion* or *commotion* of the brain, although inaccurate as a pathological

designation, nevertheless, from a practical standpoint expresses the situation with a fair degree of exactness. It is to be presumed that the circulation, through vasomotor or other influences, is so far disturbed that the highest function of the brain — namely, consciousness — is affected in greater or less degree. There is much evidence, as pointed out by Cannon and others, that this is due to an edema, the extent of which determines the degree of disturbed consciousness. A practical criterion of the outcome of such cases as we have hitherto considered lies in the course which the disturbance of consciousness takes. This is particularly well illustrated by the second case, in which the patient after a fall of moderate severity was able to walk and talk with a certain degree of rationality; a condition which later passed into a state of confusion and increased disturbance of consciousness, no doubt an indication that the edema was increasing, though by no means to the point where life was actually in danger. In all such cases, however, one should be sceptical of the outcome until a distinct change for the better in this respect has taken place. Under proper treatment, chiefly by rest, a recrudescence of the edema is not likely to occur when once improvement has begun.

The determination of treatment is often a matter requiring much judgment and discretion. The conventional ice bag, purgation and similar stereotyped methods no doubt are of little avail. The one absolutely important measure is to insist upon complete relaxation in bed, with the avoidance of anything likely to disturb the patient. Unless the original injury is of such a character that signs of increasing intracranial pressure become manifest, nature without the assistance of drugs will prove the best restorative. If, on the other hand, the patient is manifestly growing worse with deepening coma, the all important question of surgical intervention presents itself. In the absence of compound or comminuted fracture, or other immediate surgical indi-

cation, the greatest conservatism should be practiced in attempting decompression in cases of ordinary so-called concussion. The brain is capable of standing a very considerable degree of edema without succumbing to the pressure, and it is more than likely that in certain cases the added traumatism of an operation, however skilfully conducted, is sufficient to turn the balance against the patient. In this type of case, therefore, decompression, in my judgment, is justified only when the signs of pressure are manifestly increasing; and even then, not until it has become evident that the patient is not likely to survive without radical interference. In the second case quoted above operation was considered only to be dismissed; for the reason that the boy, although clearly growing worse over a period of several hours, still was far from being deeply unconscious, and showed no signs of immediate dissolution. The event justified conservatism, as shown by the remarkably rapid recovery after the symptoms had advanced to a certain somewhat alarming, though not threatening, point. In the third case, a surgeon was summoned and the question of shaving the head preparatory to operation was seriously considered. Here, again, the waiting policy was entirely justified by the gradual but steady improvement in the patient's condition. The one consideration in favor of conservatism in this case was that, although the patient was very stuporous, she still did not show any indication that this mental state was increasing. In general, therefore, it may be said that the most important determining factor in the prognosis of cerebral injuries manifesting themselves by general symptoms is, put in commonplace language, whether the patient is improving or not, such improvement being estimated by the condition of consciousness.

Although a sharp grouping into classes is neither practicable nor desirable, it nevertheless conduces to clearness to make certain more or less artificial distinctions. In a

second group we may, therefore, place those cases in which the injury to the brain has been so severe that actual laceration, together with multiple hemorrhage, presumably has taken place. Such injuries are often, though by no means invariably, associated with fracture of the skull,* either compound and comminuted, or of the simple linear variety. The general symptoms of such severe traumatisms are similar to those described for the slighter injuries, but naturally, much more marked in degree. The coma is often profound from the moment of reception of the blow, and the criterion of the degree of disturbed consciousness is naturally therefore, minimized in importance. Apart from the general edema, which no doubt is the usual cause of death, the immediate injury of certain functionally important parts of the brain assumes increasing significance. It is, however, extraordinary how great a degree of destruction may occur in the cortex if a silent area be involved without occasioning undue disturbance to the patient or leading to any permanent defect. The following case is a very striking example of this fact, and also illustrates certain features of severe traumatisms to the skull.

A boy of ten was struck by an automobile, producing an extensive fracture of the skull in the left posterior parietal region. He was not deeply unconscious, and there was no immediate vomiting or convulsion. The dura was badly lacerated and the brain substance oozed freely from the wound. There was, however, no extensive hemorrhage at the site of injury. Splintered bone was removed by a physician, and the skin of the scalp stitched together. After a few days the temperature rose to nearly 103 degrees.†

* No reference is made in this paper to gunshot wounds and their consequences, nor to the details of the effect of fracture. For a valuable discussion of "Fracture of the Base of the Skull," see Walton, Boston Med. and Surg. Journ., 1904, cli, 641. In this paper Walton lays stress on the importance of inequality and immobility of pupils as a grave prognostic sign of fracture.

† In the absence of meningeal or other infection, an elevated temperature points to cerebral laceration, and is not necessarily a bad prognostic sign.

When I saw him, the fourth day after the accident, he had not recovered consciousness, but was able to swallow and ate with apparent relish. He had not spoken since the injury. Between the stitches of the scalp wound apparently uninfected brain substance was oozing. During the examination there was constant twitching of the right facial muscles, constant spasm of the right arm, conjugate deviation of the eyes toward the right and extreme nystagmus. The pupils reacted to light. There was paralysis of the right leg, with definite Babinski response. The patient was deeply stuporous but could be roused, though not to the point of speaking. Beyond a liberal administration of urotropin, and scrupulous surgical cleanliness, together with rest, no treatment was instituted. The boy made an uninterrupted recovery, and apart from a slight disturbance in speech was well at the last report.

This case is an example of the general group in which a violent blow on the skull with extensive laceration of brain substance, but without involvement of functionally important areas leads to no permanent disturbance. The irritative phenomena which developed soon after the injury indicate that the brain as a whole and particularly the motor areas were involved in the general contusion or, at least, were the seat of very definite localized edema. Apart from the immediate surgical intervention which the compound fracture necessitated, the outcome demonstrated the wisdom of allowing natural processes to care for the manifest edema and intracranial pressure. It is at least possible in this instance that the opening in the skull caused by the original injury and subsequent removal of bone, aided in recovery, alarming as the appearance seemed to be. Such instances as this might easily be multiplied * but this is unnecessary since they all illustrate a type of injury characterized by extensive laceration and even disintegration of portions of the brain. Here again, regarding the matter from a neurological standpoint, the important considerations are whether in such cases the brain has been so far damaged that it can

* A case of much interest in this connection has been reported in detail by Walton and Brewster: "Fracture of skull, probably involving the base; recovery after operation; analysis of the aphasia," *Boston Med. and Surg. Journ.*, 1906, cliv, 630.

no longer sustain life, and whether artificial means should be adopted to assist the natural processes of repair and ultimate recovery. There is no doubt room for difference of opinion as to the proper treatment of such cases. I am aware that there is a growing feeling on the part of surgeons particularly, that surgical intervention by means of extensive decompression is harmless in itself and may avert the dangers of increasing edema. This is a matter in which no definite rules of procedure can be laid down; each case must be decided on its merits; but considering the matter from a non-surgical standpoint, I am still strongly inclined toward conservatism for reasons already stated. If, however, a decompression is attempted, the opening in the skull should be extremely liberal, and if the condition of the patient warrants, an opening may well be made on both sides. It leads beyond the scope of this paper to discuss these indications in detail; but the general statement may be made that in desperate cases, such radical procedure is not only admissible, but actually demanded. If, however, the patient shows no manifest change for the worse at the end of twenty-four or forty-eight hours, operation should at least be delayed, or lumbar puncture performed as a possible palliative measure.

A far more difficult class of cases is that in which the original injury is significant, not only because of the immediate danger to life but also because of injury to functionally important parts of the brain. I pass over the large group of focal hemorrhages, particularly from the middle meningeal artery, usually easy of diagnosis and definite as regards treatment. An interval of consciousness followed by deepening coma with manifest involvement of the motor area of one side constitutes a symptom complex which demands immediate surgical intervention.

In the absence of definite focal signs pointing to the site of the lesion the question of procedure often becomes one of extreme difficulty, as illustrated by the following case:

A man of 30 fell January 16 on icy steps, striking the side and back of his head. He was able to get up, went into the house, and asked to have a physician called. The accident happened at half past seven in the evening and, at the end of half an hour or thereabouts, he became unconscious, recovering consciousness again at midnight. There was bleeding from both ears and both nostrils, with leakage of cerebrospinal fluid from the ears, and probably also from the nostrils. The left pupil was dilated and without reaction. Respiration was of the Cheyne-Stokes type, ranging from two to twenty-five a minute. When he recovered consciousness he apparently understood what was going on about him and what was said to him, but was totally aphasic. At the end of two days paralysis and anesthesia of the right hand and foot developed, sparing the face. There was increased knee-jerk and wrist-jerk on the right, together with an ankle clonus. He was seen in consultation by Dr. John Homans, the second day after the injury. Dr. Homans decided not to attempt an operation in spite of the clearly demonstrated skull fracture and evidence of focal disturbance on the left side of the brain as shown by the paralysis and aphasia. The patient soon after developed false ideas of a persecutory character, and on several occasions entirely lost his self-control. He drove through the town brandishing the remains of a gun, and also made a definite attack upon his physician with a pistol. He was entirely unable to express himself, owing to damage to the speech area. In addition to these difficulties he had a troublesome diplopia, some difficulty in swallowing and in micturition. At the end of ten days he was able to repeat words of one syllable. His memory for recent events was lost and he also had the characteristic retrograde amnesia for events immediately preceding the fall. Up to the time I saw him, on February 6, about three weeks after the accident, he had improved somewhat in all respects, but his speech and memory remained defective, his self-control was imperfect and he was often menacing in manner and action. When examined three weeks after the onset, he had slight weakness of the left internal rectus, of the muscles of the right motor fifth distribution and a paresis of both seventh nerves, more marked on the right. The fundus was normal. His pulse was 76, regular, and the blood pressure 125. There was slight ataxia of the hands, but sensation and motion were in general normal. The knee-jerks were normal but active, and the other reflexes unchanged. Spontaneous speech was possible, and he was able to repeat test sentences without mistake. Further examination showed an entire incapacity to name objects held before him, although he appeared to recognize the use to which such objects were put. He also had total incapacity to read and was unable even to name individual letters. He could not write his own name. On the other hand, ordinary conversation he appeared to understand. Complex orders he was entirely unable to perform, and he showed confusion in simpler ones; as, for example, the difference between his right and his left hand. There was in gen-

eral a very surprising contrast between his capacity for spontaneous speech even to the extent of carrying on a reasonably intelligent conversation, and the defects enumerated above. In spite of the fact that he had considerable insight into his condition, certain definite delusions persisted, together with periods of considerable excitement. He had improved materially and a somewhat favorable prognosis was given. His excitement, however, persisted, particularly at night, necessitating his removal to a special hospital, where, after a protracted period of mental aberration, he finally, after several months, recovered sufficiently to be discharged. His present condition is not definitely known.

This case may serve as an example of a group in which severe contusion of the brain takes place, accompanied by fracture and definite focal symptoms. The interval of consciousness, brief though it was, is interesting in view of the violence of the blow. No doubt this is to be explained by the rapid development of edema and blood extravasation, the full extent of which was relieved somewhat by the escape both of blood and cerebrospinal fluid through the ears and nostrils. The fact, however, to which special attention should be drawn was the serious after effects of the injury, and particularly the paralyses, aphasia and mental disturbances. v. Monakow* has made an admirable distinction between permanent or residual and temporary symptoms as a result of traumatism or other injury to the brain. By permanent symptoms he means those which are not due to the shock of the original injury but which remain as evidence of definite focal lesion. He finds that such residual symptoms are far less in degree than one ordinarily expects. On the other hand, temporary symptoms due to what he terms the action of diaschisis are at first extremely pronounced, and later, as the effect of the shock wears off and the brain is able to readjust itself, disappear. This distinction, always vaguely recognized but very explicitly stated by v. Monakow, should certainly be borne in mind in

* v. Monakow: *Neur Gesichtspunkte in der Frage nach der Localisation im Grosshirn*. Wiesbaden, 1911. *Correspondenzb. f. Schweizer Aerzte*, 1909, No. 12.

estimating the outcome in such a case as that quoted above. Even the paralyses and the aphasia, apparently indicating serious destruction of the areas of motion and speech, were in this case temporary symptoms, which natural processes were quite able to rectify without surgical intervention. Dr. Homans' judgment in the case was, therefore, entirely justified by the event.

In general, it may be assumed that such focal symptoms as were observed in this case were due to laceration or hemorrhages within the brain substance. It may be taken, as a fair differential point between so-called concussion and actual contusion of the brain, that in the former case focal symptoms are not likely to occur, whereas in the latter, they are often a conspicuous feature of the clinical picture. However definite such focal symptoms may be at the beginning one should be conservative in predicting their permanency, as illustrated by the case under consideration. It is coming to be recognized that the brain may suffer a very considerable degree of injury, sufficient to produce marked defects in the way of paralysis, aphasia and the like, and yet recovery may be complete.* The explanation for this is to be sought partly on the basis of the theory elaborated by v. Monakow; and partly that the destruction is apparent rather than real, and that the cortex is by no means deprived of functional efficiency. An analogy may easily be found in the extraordinary improvement in hemiplegia following capsular lesion, in the often unexpected recovery from poliomyelitis, or more striking still, as recently described by Horsley, in the return of function after a complete excision of a so-called motor area.† The practical lesson to be learned from these facts is that in spite of extensive focal disturbance the recovery from a brain injury may be essentially complete.

* Walton and Brewster, loc. cit.

† Horsley: The function of the so-called motor area of the brain. Lincroft Lecture, Brit. Med. Jour., July 17, 1909, p. 125.

A far more subtle question is involved in the mental disturbances which may follow traumatisms to the skull with consequent injury to the brain, as in the case just quoted. Here we are on wholly uncertain ground inasmuch as nothing definite is known regarding the location of the higher psychological functions. In spite of the evidence afforded by the famous "crowbar case," tumors in the prefrontal region and other lesions of that portion of the brain, we are as yet far from asserting that the frontal lobes constitute the only or even the essential psychological area. It is even going too far to diagnosticate lesions of this portion of the brain when mental symptoms are conspicuous, although the suspicion is justified that this portion of the brain at least takes part in the general disturbance. The persistence of mental symptoms after head injuries is by no means uncommon, even to the extent of definite delusion formation. Inasmuch as we know little of the mechanism of the development of such symptoms, we can say even less of their probable permanence. In giving a prognosis it is as well, therefore, to be conservative and never to deny the possibility that some mental defect may persist for a long period, or even permanently.

It would carry us too far to discuss at this time the various possibilities of focal lesions. It is sufficiently evident that traumatisms of the skull may be of so varied a character that any portion of the brain may be involved sufficiently to give rise to localizing signs.* Inasmuch as such signs are frequently transitory and usually do not permit of immediate operation for their relief, it is well to fix our attention upon the later and more permanent results, or the so-called residual symptoms of v. Monakow. Here again, the time does not permit entering into details, but the general sub-

* In an analysis of 500 cases of intracranial injury, Phelps found that in 286 cases of basal fracture, 110 recovered and 176 died; of 116 cases of fracture confined to the vertex 95 recovered and 41 died; of 98 cases not accompanied by fracture 41 recovered and 57 died. *Traumatic Injuries of the Brain and its Membrane*, Appleton, 1897.

ject should not be passed over without reference to perhaps the most important and distressing of the permanent results of brain injury, namely, epilepsy. It is an established fact that traumatisms resulting in permanent injury to the motor cortex not infrequently gives rise to epileptiform seizures, usually of the Jacksonian type. This again should be borne in mind by the physician in giving a prognosis, particularly in those cases where there has been early and manifest invasion of the motor cortex. Opinions differ as to the advisability of subsequent operation in cases manifesting Jacksonian attacks; but no doubt the weight of opinion is with Krause and other surgeons, who advocate exploration, particularly if there is evidence of local injury to the bone. It is, however, a much simpler matter to discover the source of irritation than to relieve it permanently by surgical means. A final group of cases, the importance of which has been much underestimated is that in which traumatisms to the skull result in disabling nervous conditions, to which the somewhat abused term "traumatic neurosis" may properly be applied. It has been my lot, for example, to see a number of firemen in part or wholly incapacitated by injuries of the character under consideration. Of these the following is a typical example:

An officer in the Boston Fire Department, 41 years old, of exceptional physique, on February 7, 1910, while working at a fire fell down a flight of stairs, presumably striking his back and the back of his head. He was able to get up, and to continue on duty that day and part of the next. He then began to have pain in his head, and was so far incapacitated that he did not return to duty. He became very nervous, tremulous, unsteady on his feet, had much headache and photophobia. His skull was not fractured, and his body showed no noteworthy bruises. Examination showed a rapid pulse, somewhat high blood tension, deep reflexes exceedingly active, a staggering gait, cold hands, depressed appearance, but without the development of special phobias. He was an exceptionally muscular man, weighing about 230 pounds, and in addition to his work in the Fire Department, had been studying law at night. He was much relieved by explanation, reassurance and general encouragement. He returned to work and was apparently well except for some slight tremor of the right hand, and

increased irritability. On January 14, 1912, he with other firemen was penned into a room in an upper story during a fire, from which escape seemed impossible. While in this predicament he was struck presumably by a beam from the falling roof, his helmet being crushed down on his head, causing a superficial injury to his scalp in the median line. He was finally rescued in an unconscious condition, and remained stuporous for two days. There was, however, no paralysis, or other sign of focal brain disturbance. After this second accident he remained dull and apathetic, speaking and eating little. He complained of photophobia and vertigo, and showed periods of some excitement, particularly when a fire engine went by his house. He had much pain at the back of the head, and lay for the most part with his eyes closed, showing little interest in his surroundings. His general demeanor was one of dejection and vague depression. He, however, made very few definite complaints. The tremor of the right arm noticed after the first accident greatly increased in intensity, and he later also developed weakness undoubtedly functional in character of both the anterior and posterior muscles of the left leg. In spite of rest, a long stay in the country, and vigorous psychotherapeutic treatment he has remained essentially the same, and is totally unable to resume his work. He has lost much in weight, and has the appearance of having passed through a serious illness. Mentally, he has a clear insight into his condition, there is no delusion formation, but he remains totally ineffectual both mentally and physically, and it seems probable that he will have to be retired from the service.

In another instance, a fireman of equally robust build and apparent nervous stability, after an accident at a fire which rendered him unconscious, developed various phobias and psychasthenic symptoms which after patient but ineffectual efforts at relief finally necessitated his retirement.

Such cases as these are certainly of the greatest importance both from a practical and theoretic standpoint. The mechanism of the production of such neurotic states cannot now be considered, but the fact remains that in men of exceptional vigor and nervous stability, a blow on the head may produce a permanent disability of a functional sort, which in my experience is extremely difficult to treat and far more unyielding to recognized methods than similar conditions in other persons and due to other causes.

The following practical conclusions from a study of head injuries are justified.

The outcome of a blow on the head is not to be estimated by the extent of manifest brain injury.

Fracture of the skull is not in itself of grave import.

Immediate prognosis is to be determined largely by the condition of consciousness; if the patient holds his own or improves in this respect, the outcome as regards life is in general favorable; if the coma deepens, the prognosis must be considered grave.

Focal symptoms indicating laceration are not necessarily serious complications; unless the damage to the brain be extensive, such focal signs are apt to improve or wholly disappear.

The possibility of late epilepsy and more or less permanent mental symptoms or neurotic states should always be considered.

Rest is the first essential of treatment.

Surgical intervention should be practiced with conservatism.

INJURIES TO THE SPINAL COLUMN.

Injuries to the spinal column, like injuries to the brain, derive their significance from damage to the nerve substance beneath. These injuries are incapacitating but not immediately dangerous to life unless localized in the upper cervical region.

The question has been raised whether it is possible for a blow on the spinal column insufficient to produce fracture or dislocation, to lead to a condition analogous to what has been spoken of as "concussion;" or whether in such cases, an actual hemorrhage in the substance of the cord takes place. This query cannot be definitely answered, but it is at least reasonable to presume that a condition similar to concussion of the brain, producing very possibly microscopic alterations, may occur in the cord without manifest hemorrhage. The following case suggests such a

condition, although some slight defects remain, presumably pointing to a permanent structural defect of mild degree.

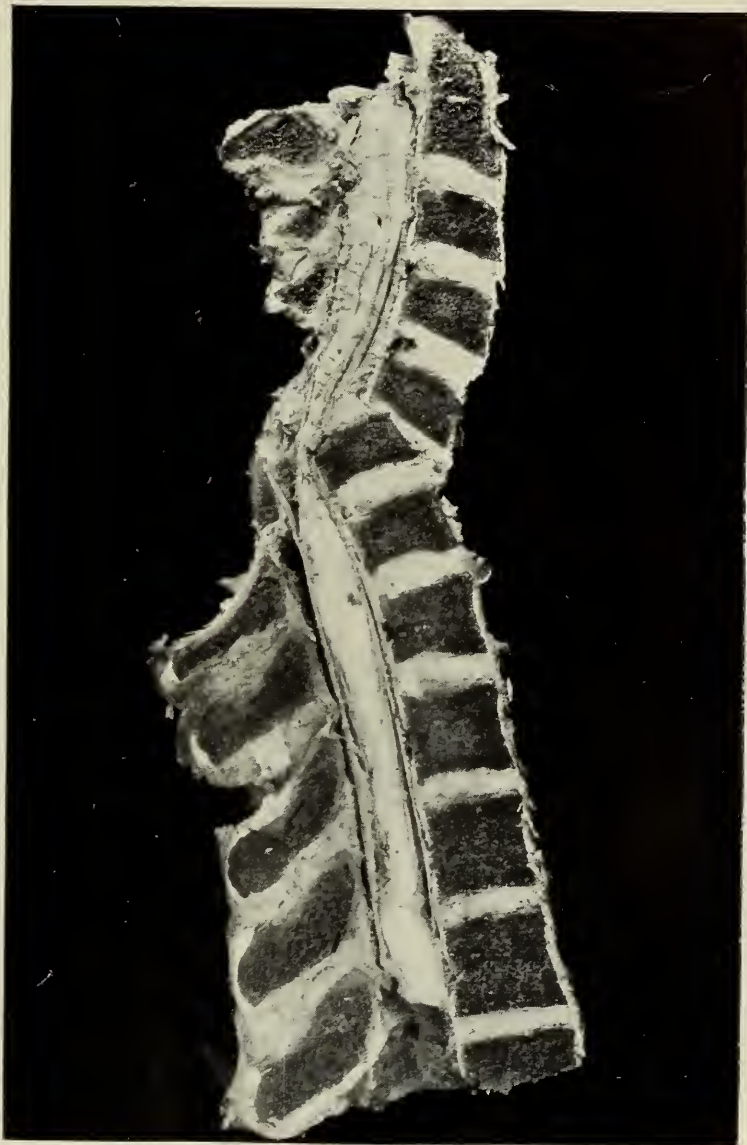
A fisherman struck his head violently against a boom. He was thrown down, striking the back of his head but did not lose consciousness. He was forthwith unable to move arms or legs and experienced a sensation of numbness over the body and extremities. In twenty minutes sensation began to return in the left hand and arm, and this improvement continued until there was slight evidence remaining of disturbed sensation. The motor power both of arms and legs also returned in great measure, but with persistent alteration of certain of the reflexes.

In this case it is safe to assume that the injury was of the nature of so-called concussion, very possibly associated with edema, and some exudation, whether hemorrhagic or not naturally cannot be stated. The point of importance is that apparently complete transverse lesions of the cord may under certain circumstances be due to the effects of concussion with good prognosis.

Between this milder type of cord disturbance from trauma and a complete disintegration of the cord, all possible gradations may exist. The more severe damage is usually due to fractures and fracture dislocations bringing about a crush of the cord through impinging bone or cartilage. The mechanics of the spine are such that immediate injury to the cord is usually due to the forward dislocation of a vertebral body rather than to fracture of an arch or lamina. In these cases, which constitute the larger proportion, free hemorrhage outside the cord is conspicuously absent. It is exceedingly rare to find any material extravasation of blood, either in the extra- or subdural space. The damage is almost invariably to the cord itself and consists of a crushing injury with such hemorrhage as an injury of this character would necessarily entail.

The following case is typical:

A young woman athlete, while performing on a high trapeze, fell 30 feet into a net, striking in such a way that her head was bent violently forward, producing a fracture in the region of the



. FIG. 1. Extreme dislocation of a vertebral body as the result of a fall, with consequent destruction of the cord by the impinging bone. The specimen illustrates the method of narrowing of the spinal canal, and the formation of a kyphos.



FIG. 2. Disintegration of vertebral body with crush of the cord due to striking the head in diving. The mechanism of the cord injury is well shown in this specimen.



FIG. 3. Probable extra-dural hemorrhage; an extremely unusual result of trauma. The cord beneath also greatly damaged. The patient lived many years and the blood clot was completely organized. Operation would undoubtedly have resulted in benefit in this case.



FIG. 4. Central hematomyelia resulting from injury to the spine. It will be noted that the cartilage is loosened from its attachment to the vertebral body, but that the lumen of the vertebral canal is not greatly diminished.



FIG. 5. Fall from a trapeze. Section cervical region, above the point of greatest injury. Hemorrhage in the posterior columns, and a slight hemorrhage in one lateral tract; none in the gray matter. Exterior of the cord perfectly normal.

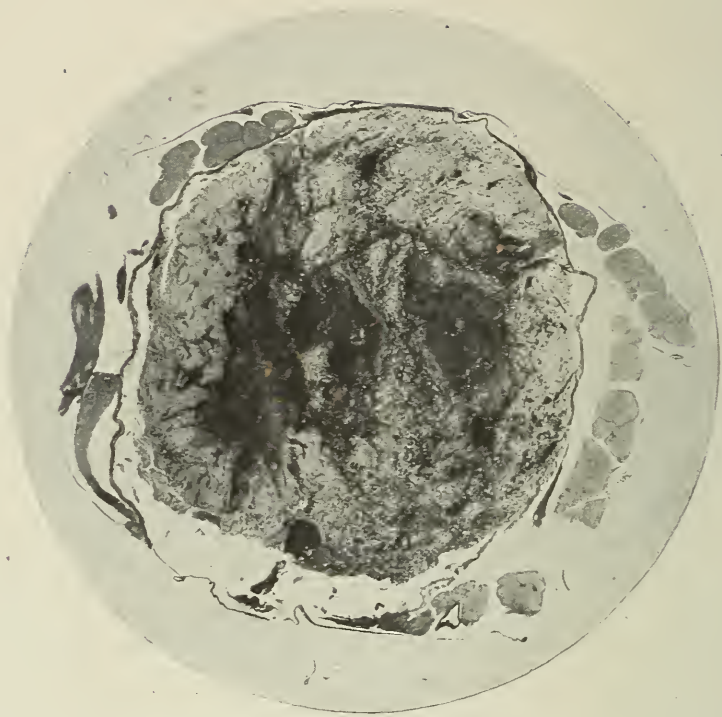


FIG. 6. Fall from a trapeze, bending the head violently forward on the neck. Crush of the spinal cord, lower cervical region, at the level of greatest intensity. Note the disintegration of the cord substance and hemorrhage within the cord. The absence of hemorrhage in the sub-dural space is noteworthy.

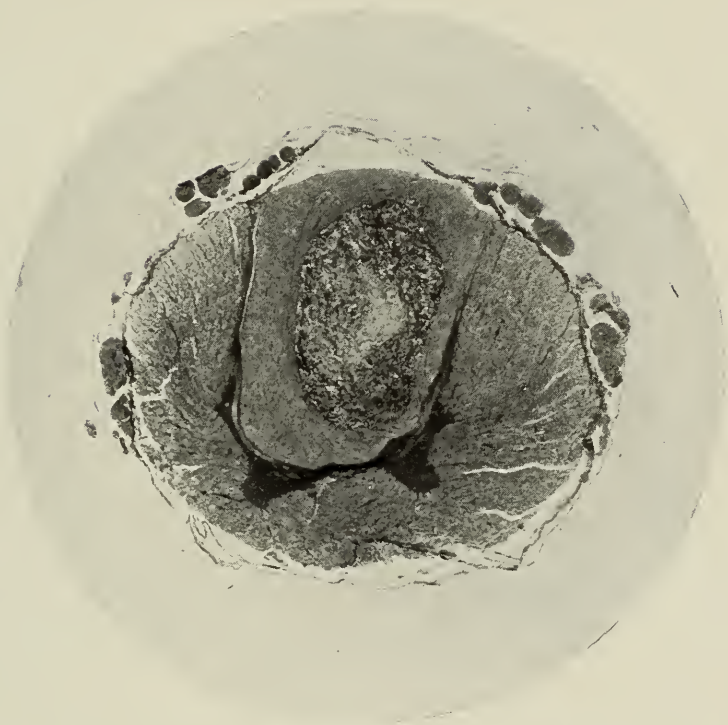


FIG. 7. Fall from a trapeze. Thoracic region below the point of greatest injury. Slight distortion of gray matter, and large tubular hemorrhage in the dorsal columns.



sixth cervical segment. A complete paralysis of sensation, motion and the sphincters forthwith developed. She was operated upon immediately, the laminectomy disclosing a crushed and softened cord without external hemorrhage. The patient died on the third day. Sections of the cord at various levels at, above and below the seat of crush disclosed no free hemorrhage whatever. The pathological condition is sufficiently shown by the accompanying photographs.

Attention should particularly be called to the tubular hemorrhage within the substance of the cord, extending far down into the thoracic region. Although this case would undoubtedly have proved fatal, it is probable that the laminectomy added to the extreme shock of the original lesion hastened her death; at least, as the autopsy showed, nothing was accomplished by this early operation. This is the usual experience, and perhaps even more than in the case of the brain, surgical conservatism is demanded. The shock of extensive laminectomy in the cervical region is no doubt greater than below, owing to the proximity of certain nerves concerned with respiration.

The neurologist is ordinarily called upon to determine the location and extent of the injury and to advise as to its operative treatment. The localization of cord segments has been so accurately mapped out by various students of the subject that the question of the diagnosis of the height of a lesion presents few difficulties. The general rule must not be forgotten that, from above downward, the nerves leave the spinal column at increasingly greater distances from the segments in which they originate; from which it naturally follows that the attempt to expose a lesion must take accurate account of this fact. A more difficult matter to decide is the extent of the lesion in any given case. Immediately following the receipt of a violent blow on the spine, the signs of so-called complete transverse destruction of the cord are apt to supervene as, for example, in both the cases cited above. It is, therefore, not possible immediately to determine the amount of damage done the cord. This

being the case it is essential to wait at least twenty-four to forty-eight hours before a decision is reached. The evidence at our disposal goes to show that whatever permanent damage is done is immediate, and that the element of gradual pressure upon which much insistence has at times been laid is fancied rather than real. If this be true no detriment to the patient will result from delay. It is my belief that immediate operation may at times so far increase the shock already sustained as to hasten a fatal outcome. It has been suggested that an immediate laminectomy for cord injury is as much of an emergency operation as one for an acute appendicitis. This radical position is certainly not borne out by the facts nor by the pathological findings. Delay in surgical intervention is, therefore, always to be advised except in those relatively rare instances in which there is pain with definite fracture of the spines or laminae, which through displacement might still further injure the already damaged cord. In the absence of such indications delay is not only justified but desirable in the determination of a more exact diagnosis. During this period the patient should be carefully protected to avoid possible bony displacements. If at the end of forty-eight hours there is absolute loss of sensation, motion, and sphincter control below the seat of the lesion, together with abolition of deep reflexes, it may be presumed with a fair degree of certainty that the cord is irremediably damaged. If, on the other hand, signs of improvement begin to show themselves and the patient's condition justifies the operation, a laminectomy may be indicated. Perhaps even more than in the case of the skull the improvement in the technique of spinal surgery permits recourse to operation in these desperate cases; and it is probable that the removal of the posterior portion of several vertebrae permits the cord a better opportunity to recover its function. Certainly the operation is relatively devoid of danger in skilled hands. In general, therefore, regarding

the matter as I am expected to do from a neurological standpoint, presumable complete destruction of the cord is inoperable in the sense that recovery in any event is impossible. In spite of much experimental work on the subject, and the occasional report of cases seeming to controvert this testimony, evidence is still wholly lacking that the cord has any power whatever of regeneration. All that can be hoped, therefore, is to give such fibers and elements as remain intact the best possible opportunity for the resumption of their normal function. If the signs point toward the persistence of certain tracts, it is altogether probable that their further restoration may be aided by the removal of constricting bone. This appears to be the justification for laminectomy. It should also be said in this connection that a readiness to resort to operation should be determined in part at least by the location of the lesion. Cervical lesions of extreme degree are almost invariably fatal. Lesions in the thoracic cord and at the lower levels do not threaten life except through probable complications, cystitis and the like; considering, therefore, the inevitable disability, carefully considered but radical measures are often justified.

We may conclude from a study of the clinical disturbances and pathological findings in traumatic injuries of the cord:

That hemorrhage external to the cord is unusual and need not be seriously considered in deciding upon operation;

That concussion of the cord without definite microscopic lesions is a possibility;

That the damage to the cord is immediate following the injury;

That delay in operation is advisable;

That operation is unavailing when signs of complete transverse lesion persist;

And that laminectomy may help toward restoration of the functions of a partially damaged cord.



ARTICLE XII.

THE SURGICAL TREATMENT OF HEAD
INJURIES AFFECTING THE BRAIN.

BY JOHN HOMANS, M.D.
OF BOSTON.

Read by C. C. Simmons, M.D.

DELIVERED JUNE 11, 1912.

THE SURGICAL TREATMENT OF HEAD INJURIES AFFECTING THE BRAIN.

THE surgical treatment of injuries to the brain is not by any means a modern conception, but the intelligent application of physiological principles to this branch of surgery is, in reality, but little understood. One would be tempted to believe from what he had been taught, that the character of a skull fracture was more interesting and worthy of classification than the condition of the brain inside it. Obviously this is not so. Yet violence of certain kinds tends to produce certain types of fracture, and with a certain regularity certain types of brain injury as well. Therefore, correctly to interpret any traumatic disturbance of the brain one must understand the mechanism of skull fractures and their association with the external signs.

Two main varieties are seen — first those due to indentation, and second, those due to a bursting force. Any solid object meeting the skull with sufficient force is apt to indent it. If the object is small, the bone is punctured; if it is large a considerable part of the skull may be driven in. It is idle to divide these injuries into classes — compound, comminuted, depressed or whatever. An indented fracture, or a fracture of the inner table, alone causes a rather local injury to the brain, often deep, but not necessarily disabling. It calls less for measures to relieve pressure, than to stop hemorrhage, combat sepsis, remove depressed bone, and at once minimize immediate damage, and forestall future irritation or impairment of the central nervous system. Rather incidentally a deeply lying bullet or other

foreign body may be removed. With or without the evidence of an x-Ray, which, however, is highly desirable, such fractures should be explored and repaired. Even when there is a considerable amount of dirt and hair in a gaping opening into the head, careful thorough irrigation and mechanical purification of the wound will often result in a satisfactory cure. Both the injury and the treatment may perhaps be described as direct, in contradistinction to the second important class of traumata, about to be described, in which the effect of a blow is felt at a distance from where it actually meets the skull, and the treatment often ignores the position of the external wound or bruise.

These injuries are the so-called bursting fractures. You will find an excellent discussion and illustrations of these lesions in a paper by Walton, published in the *Annals of Surgery* for 1904. The old view that fractures of the base were produced by contrecoup was succeeded by the irradiation theory of Aran² by which blows upon the vault were shown to result in cracks passing into the nearest fossa. The bursting fractures of Hare,³ von Wahl⁴ and others presupposed a force acting upon the sides of the skull and causing its walls to spring.

The impact which produces a bursting fracture does not indent the skull. It spreads the sides and so produces radiating cracks often at a distance from the point of impact. The classic illustration of this principle is the crushing of a rounded, somewhat elastic nut, as a peccan. Under pressure from each end a series of radiating cracks appear, whose general direction is from pole to pole, but whose exact course is determined by the weaker portions of the shell. In the skull these cracks appear to take, in a general way, the direction of the force of the blow, and pass toward the opposite pole.

Now it happens that in the human skull there are certain strong and weak points — buttresses and weaker interme-

diate portions.⁵ Bursting fractures almost invariably run through the less protected regions, the three fossæ, and external evidence of the cracks in these fossæ is often comparatively easy to obtain. You are all doubtless familiar with the bleeding from the ear which accompanies fracture of the base, but you do not always associate this sign with a fracture running from near the middle line through the petrous portion of the temporal bone (taking in the middle ear and rupturing the drum), across the thin temporal fossa and out across the vault of the skull. The temporal fossa, being the middle one of the three, is naturally the favorite seat of these fractures, but variations in their course are common. The fracture may be only an inch or two in length, or it may originate in, or branch into the anterior, or, less frequently, the cerebellar fossa, or it may be, and often is, bilateral.

In so far as these cracks are an indication of the amount the brain is shaken, and a possible cause of a division of the meningeal vessels in accessible regions, they are important, but as mere breaks in the continuity of the skull, they are of little interest.

Returning to the nature of the cerebral injuries produced by this type of blow, it is plain that considerable damage may be done whether or not these fissures are present. Skulls vary with age and other causes in their susceptibility to fracture, and a blow severe enough to bruise and even lacerate the brain may not crack the skull. The effect of a severe blow of this character is spoken of as concussion. This term covers, in an indefinite way, the loss of consciousness, which is its most recognizable sign, and the damage to the medulla, which probably produces its severer manifestations. In a paper of this sort physiological details are out of place. Roughly speaking disturbance of respiration is most easily brought about, then failure of the vagus control of the heart and finally lowering of blood pressure due to

injury to the vasomotor center. Thus we commonly see loss of consciousness which without other signs is transient; or we see loss of consciousness plus irregular respiration — and with this we should expect the compensatory slow pulse and high blood pressure; or we see unconsciousness and irregular respiration plus a rapid pulse, and then if the vasomotor center does not come to the rescue and raise the blood pressure, the patient dies.

All these we may call the physiological results of concussion. Anatomically there is usually edema, possibly accompanied by fine punctate hemorrhages which cause a swelling and hence compression of the brain. Therefore, so far as surgical treatment goes, we have to combat the bad effects of this compression, provided the patient survives the initiatory blow. With regard to the time at which this swelling comes on I can only say that I have seen a tremendously edematous brain within three hours of an injury, and a local cortical edema producing paralysis which only showed its effects ten days afterward.

If we carry the injury further, we may suppose that the brain is so bruised and shaken that it becomes lacerated. This laceration is quite independent of fracture, that is, anatomically, and it probably takes place on the opposite side of the head from which the blow was received. Thus in severe blows upon the occiput, or vertex, the inferior part of the frontal and temporal lobes will usually be affected. The laceration is on the surface and often extends several centimeters in depth. With it is more or less abundant hemorrhage from the cortical vessels, that is, hemorrhage into the pia. The effect of this is compression of the brain. The extent of the laceration, the greater part of which is generally inaccessible to surgery, can only be guessed at, not measured from the outside.

Of the immediate signs of laceration there is only one which is reliable. This is the evidence obtained by lumbar puncture.

The cerebrospinal fluid has such a rapid circulation that no bleeding can take place beneath the dura without at once coloring it. If, therefore, we find bloody fluid on lumbar puncture — and it is often surprisingly like clear blood — we know that we have laceration to deal with. This is an immediate sign. Later on there is always a marked elevation of temperature, though this may be rather a sign of medullary disturbance and may not appear for from twelve to twenty-four hours.

A third and less common form of injury to which the brain is subjected is the compression from dural, or as we usually call it, meningeal hemorrhage. This means nearly always anterior or middle meningeal hemorrhage. This is the only direct result of a bursting fracture, and depends upon the fact that such a fracture most commonly passes through the temporal fossa. The meningeal vessels are thus torn by the break, especially when they groove the bone. They generally bleed outside the dura, and the force of the arterial stream dissects the meninges from the skull, and may form an enormous hematoma extending well up over the parietal region and the motor part of the cortex. The principal signs of such a lesion are, therefore, failing consciousness and paralysis coming on slowly (sometimes very late) after an injury from which the brain may otherwise be recovering. Such a hemorrhage will not of itself give bloody fluid on lumbar puncture. Therefore, if we have increasing pressure symptoms without bloody fluid, we suspect an extradural hemorrhage. If the fluid is bloody, we have intradural, and we may have extradural as well. In either case, as I shall show you, the only reasonable treatment is the same, so that this difference is less important.

Recapitulation. Summing up briefly the pathology of head injuries we may lay down the following rules. More or less local lesions result from indented fractures, and bruising or crushing from bursting fractures. Local inden-

tation causes local laceration, and often hemorrhage and sepsis. The immediately disabling, as well as the late effects depend somewhat upon the location of the injury. Bursting fractures are associated with edema, bruising, laceration and occasionally dural hemorrhage. Even blows which do not result in fractures may produce the same effects. These factors all cause compression of the brain, and this compression is associated with signs of disturbance of medullary centers — alterations in the respiration, pulse rate, and blood pressure.

Symptoms. I shall not give much time to a description of symptoms. There is no such thing as a constant clinical picture. Any one individual sign is often valueless and I prefer to take up the indications for treatment and let the symptoms with which you are all familiar take care of themselves. After all it is the combination of the signs and the sequence of events that is really important.

Obviously, loss of consciousness is the most fundamental evidence of cerebral damage. Yet this means relative and not absolute loss. You may see a patient within an hour or two after an injury apparently bright — often too bright — and yet he may afterwards have no recollection of the period at which you saw him. Or you may see deep unconsciousness. In either case the changes in consciousness, in combination with other signs, are more important than the patient's state of mind at any one time. In general, there is likely to be an improvement after the first shock of the injury is past. If this does not occur, or if unconsciousness deepens, you are dealing with a severe injury.

Other signs of concussion are the alterations in respiration, pulse and blood pressure. Immediately after an injury in combination with this loss of consciousness there is usually a depression of the medullary centers (rapid respiration and pulse, and low blood pressure). If the patient is to live they will revive. Therefore, we should expect deep res-

piration, slow pulse and high blood pressure as compensatory effects after the preliminary depression. Or the injury may be so severe that this compensation is impossible. A low temperature, followed by a rise to, or above normal is a common early sign, but a rapidly rising temperature, to 105 or 108 degrees, is evidence of a very severe disturbance. The symptoms of compression are usually supposed to be like those of brain tumor; headache, vomiting, choked disc, high blood pressure, increased reflexes, spastic limbs, and so on, but as in brain tumor, are, on the whole, most often noticeable by their absence. An alcoholic with a fracture of the base will remain unconscious, his reflexes will be absent, his blood pressure low. In other words, he does not react normally. It is my experience that soon after injury the classic signs of compression are often absent, and the diagnosis must be made by inference. Here again the changes are especially important. Choked disc should be, and is, a most reliable sign, but some time probably is necessary to produce it, and most of us do not use an ophthalmoscope well enough to detect it in its early stages.

The evidence of hemorrhage is obtained from many sides. There is a probability of cortical laceration and pial hemorrhage in all bursting fractures. Therefore, an unconscious patient, with bleeding from one or both ears, is likely to be bleeding internally. Bloody fluid on lumbar puncture confirms a guess at an intradural hemorrhage. Clear fluid on lumbar puncture leaves open the question of extradural bleeding which must be settled by the more or less classic signs of this lesion.

Indications for Treatment. The treatment of head injuries, whether operative or not, has for its first object the saving of life, and for its second, the prevention of unnecessary damage to the brain — damage which may show itself in the retardation of convalescence and in permanent cerebral defects. In order to attain these objects, we must

distinguish between the cases which require no treatment beyond observation and rest in bed for a limited time, the cases which are benefited by operation, and finally those which cannot conceivably be benefited at all.

In the more severe bursting fractures and crushes the patient either dies at once or lives on for a time with a hopelessly damaged brain. In such cases the brain apparently fails to react, there is little compression to relieve and no accessible hemorrhage to drain. The patient may live several days and die with rapidly rising temperature, rapid pulse, shallow rapid respiration and low blood pressure. The signs of laceration and medullary disturbance are present and the cerebrospinal fluid is markedly bloody. I have carefully watched a number of such cases operated upon, or not, and though I can say that drainage and decompression seemed to improve the pulse and respiration temporarily, it hardly interrupted the course of the patient's dissolution. In one case I tried cold bathing to keep down the temperature without being able to affect it in the slightest, showing how fundamentally the brain is disturbed.

In the cases merging on the one side into this hopeless class, and on the other into the obviously simple mild injuries, is the field for operative treatment. The principle of operation is simply decompression, accompanied, if necessary, by drainage. This principle was strikingly demonstrated to me by Dr. Harvey Cushing some years ago, and has formed the basis of my subsequent work. We operate, then, to save life by relieving pressure, checking and draining hemorrhage; and we attempt to insure restoration to normal by allowing the brain room to expand when swollen, even if the amount of damage would not necessarily have been fatal. It is very hard to say how often surgery actually saves life — seldom I believe in such a field as this — but in my experience, it profoundly alters the convalescence. No one can see the improvement in pulse and res.

piration which immediately follows decompression in swollen bloody brains without being tremendously impressed, and no one can observe the rapidity of convalescence and completeness of recovery, even in the severer injuries, without astonishment. I have as yet had too little experience to speak with any authority of the results in preventing the onset of the abnormal post-traumatic disturbed mental conditions which are occasionally seen, especially by the alienists. I believe, however, that operative measures tend to do away with them.

In the milder concussion cases surgery is hardly necessary. There is no doubt in my mind that giving the brain more room under conditions in which it is swollen is always of benefit, but when a week's rest in bed will accomplish the same thing, an operation with its resulting cranial defect is generally unjustifiable. Given a patient who is "knocked out" by a blow for even a few minutes, who ignores the injury, has nausea and headache for a number of days, but perhaps does not complain of them, who goes about his business and at the end of several weeks finds himself disturbed, unable to work, restless and miserable; such a patient would probably have been restored to normal by relieving pressure in the first place. On the other hand, he would probably have recovered only a little more slowly under complete rest. In other words, the milder cases should be carefully observed until the headache, increased blood pressure and exaggerated reflexes disappear. It must also be borne in mind that the younger the patient, the more rapid and complete is the recovery and the less radical the treatment.

I may make myself more clear in regard to the principles of treatment of injury to the head if I describe the steps which I find most useful in going over a patient.

In the first place get the best history you can of the accident, if there was one, especially as to the kind of blow the

patient received — whether he fell on the back of his head, or was struck on the side, etc. If there is any doubt of a blow or fall make sure the patient is not in coma from diabetes, uremia or alcohol. Find out whether there have been any changes in consciousness since the injury and if so, what.

It is important to notice if the patient appears to be in shock or if he seems to be on the up grade. Study the pulse, respiration rate and temperature. Size up the patient first before going over him in detail. After this preliminary survey do a lumbar puncture to settle the laceration question, look at the eye grounds with an ophthalmoscope and take the blood pressure. By these means you establish the facts and the general character of the injury. Then, and this is really less important, go over the patient in detail. Look over the head for bruises, tender spots, hemorrhages from ears or other orifices. Examine the pupils and their reaction. Try to elicit movements of the face by pinching, or pressing on the supraorbital notches. Going down the body pick up the various limbs, see what voluntary movements the patient can make. Are the limbs spastic or flaccid? Try the reflexes everywhere: wrist- and elbow-jerks: knee-jerks, Achilles, Babinski and Oppenheim reflexes. In other words, go over the body systematically for signs of general and then local brain damage.

I should lay more stress on the detailed examination if it were not often so misleading. For instance, early after the injury the reflexes are abolished and may remain so even when the brain is considerably compressed. Differences between two sides of the body are more important but may be deceptive. Hemorrhage from the right ear with increased reflexes of the opposite side of the body suggests a meningeal hemorrhage on the right. The hemorrhage may, however, be on the left — a nice soft cushion compressing the brain against the opposite side of the skull. A bruise

on the corner of one jaw and a facial palsy of the same side suggest an injury to the brain on the side opposite to which the jaw was punched. I operated on one such case and found a hemorrhage on the side I opened — but there was much more hemorrhage on the opposite side — at autopsy.

On the whole, I should place the value of the signs which localize the injury on one side of the brain or the other rather low, at least as one sees them when the decision as to treatment must be made. And I should place the general evidence of injury and its course, including lumbar puncture, very high. At the present time I have almost made a rule as follows: If the patient when seen from six to twenty-four hours after injury shows a slow pulse, rapid and irregular or shallow respiration, low blood pressure, a temperature of 103 degrees, or over, bright bloody fluid on lumbar puncture and deep unconsciousness, I am not inclined to operate because I feel that I shall gain nothing. Up to this condition I operate on every case at once, provided the case demands any surgery. I think that it is right to watch any case through its early abasement and possibly deceptive recovery if I am prepared to operate at any minute. That is to say, I should carefully observe most cases seen in the first few hours, but if the patient does not soon improve, or becomes worse, I operate at once. In a case of doubtful progress I should feel happier to have operated than to have let the patient drag along for days fluctuating between better and worse.

The selection of the field of operation is a simple matter. As far as I have gone into the subject I know of only one condition on which the symptoms would lead the surgeon to one side or the other of the head. This is the typical extradural hemorrhage in which we confidently expect to find the bleeding immediately inside the skull and opposite to the paralyzed side of the face and body. In other cases there are no reliable guides. Personally I take any lead I

can get, such as a bruise on one temple or the other, bleeding from one ear, tenderness over one temporal bone or paralysis of one side of the body. I do not, however, expect to go to the seat of gravest local disturbance. All I expect to do is to give the brain more room and for this, perhaps, the question of right or left is a small matter. If in doubt I operate on the right to avoid possible damage to the speech areas, but I am prepared to open both sides if necessary.

For all the purposes for which a decompressive operation is done the temporal region is the ideal site, for through this region most of the fractures run. Here middle meningeal hemorrhage is to be found and stopped. Here the skull is thin and easy to open. Here is the strong temporal muscle to cover the defect in the bone and finally, and most important, here is a reasonably "silent" area of the brain to bulge into the opening. All that can reasonably be expected of any operation for fracture of the base can be done beneath the temporal muscle.

The operation which I practice is the subtemporal opening perfected by Cushing. The steps of the operation are somewhat as follows: The head is shaved over an area sufficient to uncover the temporal muscle, with a margin of say an inch. It is scrubbed as usual. To exclude hair from the field it is well to pin towels to the scalp itself in such a way as to expose only a narrow slit extending upwards and a little backwards from just in front of the ear for from 3 to 4 inches. The incision is straight, and the temporal artery is caught at its lower end. Carefully divide the deep fascia and then the temporal muscle in the direction of its fibers. Now you can with a periosteum elevator scrape back muscle and periosteum to each side so that the two halves of the muscle can be well retracted.

The bone is opened by a trephine or burr drill, as low as possible as it shelves off rapidly from thick to thin at the level of the upper edge of the squamous bone. With ron-

geurs as large an opening is now made beneath the muscle as desired. If there is no hemorrhage outside the dura, and the dura seems tense I make a large opening. Little bleeding occurs. Whatever comes from bone can be checked with bone wax. If one of the meningeal vessels is torn it may be temporarily stopped with a fragment of gauze or cotton and later caught with a fine stitch.

To open the dura catch it up with a very fine needle and carefully incise it. Then pass in a director and split it in every direction. If much bloody fluid escapes it is a good plan to place a film of rubber tissue inside the dura around the temporal lobe. If not, the wound may be closed. As the brain generally bulges out through the opening this closure is not always easy and must be carefully done. I use strong, fine black silk, after Cushing's method, and close each layer with interrupted stitches — first the muscle — then the fascia covering it — often a difficult matter as the brain may project so far as to make this hard — and finally the deep fascia of the scalp.

This makes a very strong wound requiring very few skin sutures, which may be removed in from 2 to 4 days. Absolute asepsis is essential. The strongest kind of healing is desirable, for the patient has got to go about with a bone defect the rest of his life.

The convalescence requires nothing in particular except the free administration of urotropin (I give gr. 10–20 every four hours unless hemorrhage from the kidneys occurs) which must be given by rectum until the patient can swallow. Usually the covering of the opening is prominent at first and its subsidence is the first sign of returning cerebral adjustment. The patient usually requires bromides and occasionally morphia or other strong hypnotics.

I am now going to give you what I am afraid is rather an imperfect account of several cases treated by me, at the Massachusetts General Hospital, during the last eight

months. These cases illustrate many of the points in diagnosis that I have attempted to describe.

CASE 1. W.G. No. 178225. An instance of basal fracture with concussion and slight laceration.

The patient was a man of thirty-five years — a steady drinker.

Immediate History. Fifteen minutes before entrance he was struck upon the right side of the head and the right shoulder by the step of a car. He was probably sober at the time. Unconscious for a few minutes. Recovering consciousness when first seen.

General Examination. Conscious. Rather drowsy, but when spoken to is bright and says he "feels better." Some headache. Temperature subnormal; pulse 80 and of fair quality; respirations 20. Pinkish fluid on lumbar puncture. Examination of the retinae shows a rather questionable edema. Under observation for two hours without obvious change.

Special Examination. Hemorrhage from the right ear. Hematoma behind the right ear with tenderness on pressure. Ecchymosis about the right eye. The right pupil larger than the left. All deep reflexes absent. Superficial reflexes present and equal. No muscular weakness.

Diagnosis. Fracture of the base with concussion and slight laceration. Most damage probably on the right.

Operation. Three hours after the accident. Right subtemporal incision. A fracture passes through temporal fossa and out upon the vault. Some blood wells up outside the dura from the region of the petrous portion of the temporal bone. Upon opening the dura somewhat bloody fluid and a few small clots spurt out. The tremendously edematous temporal lobe bulges through the wound — the fluid fairly bubbles out of the pia. The brain gradually flattens out as the fluid escapes. The middle meningeal artery is torn (probably in rongeur-ing the bone). The wound drained inside the dura with rubber tissue.

Convalescence. The decompression opening was prominent for several days. There was deafness in both ears, showing that the crack was bilateral. The patient seemed at times to have hallucinations of hearing voices and at

such times would become violent. He could not remember the names of people or common objects though he was not otherwise aphasic. At the end of sixteen days he appeared entirely well except for his deafness, and was discharged.

The case illustrates well the edema of concussion and the typical bursting fracture. Recovery would, I believe, have occurred, probably after a considerable period of depression, under any treatment. The patient has since been seen in excellent condition, with no defects of memory and with greatly improved hearing.

CASE II. S. P. S. No. 180378. An instance of basal fracture with laceration — complicated by alcoholism.

The patient was a man of thirty-five years — apparently a steady drinker.

Immediate History. Thirty-six hours before entrance he fell, apparently when drunk, from the step of a wagon. He was said to have struck on his head, became unconscious and remained so without especial change until he was brought to the hospital.

General Examination. The patient is unconscious, and can be roused only by pin-pricks and pressure upon the supra-orbitals to make aimless movements of all the limbs. Temperature 103 degrees; pulse 60, irregular in rate and strength; respiration 20. Blood pressure 150 mm. Lumbar puncture gives bloody cerebrospinal fluid.

Special Examination. Dried blood in the right ear. No obvious bruises on the head. Dislocation of the outer end of the right clavicle. The patient moves all the limbs except the right arm. No asymmetry of the face. Pupils equal and react. Both knee-jerks increased. Babinski present on the left. Superficial reflexes present.

Diagnosis. Fracture of the base, with laceration and compression. Alcoholism. Most of the damage probably on the right.

Operation. Right subtemporal opening. Fracture through the temporal fossa and out upon the vault. No extradural bleeding. Bloody fluid beneath the dura under pressure. Dark venous blood wells up from the temporal fossa in front. Temporal lobe not edematous. Moderate bulging

of the brain through the opening. Drainage inside the dura with rubber tissue.

Convalescence. The opening was prominent for from ten days to two weeks. The patient was restless and wild through this period. The temperature steadily fell to normal in ten days. The blood pressure gradually fell from 150 mm. to 110 mm. The wound became septic but healed sufficiently well. The mental condition began to improve in two weeks, and at the end of six weeks seemed normal, though the patient was at all times intractable. The convalescence was complicated by an operation for stricture, and the patient was discharged at the end of eight weeks.

This case is evidently on the border line. There must have been considerably more hemorrhage than was drained by operation, and yet one opening gave sufficient relief. I had supposed that a temperature as high as 103 degrees meant a fatal outcome.

CASE III. M. S. No. 178892. An instance of an extensive basal fracture with severe laceration, little or no compression, but marked medullary involvement.

The patient was a man of forty-six years.

Immediate History. Brought to the hospital with the story that he had just been run into by an electric car. Not conscious since the accident.

General Examination. In response to scratching the soles of the feet the patient makes aimless movements. Temperature 98 degrees; pulse 60 to 70, irregular in rate and strength; respirations 35, shallow, with an occasional deep sigh. During one-half hour observation the patient grew steadily worse. Eye grounds normal. Lumbar puncture not done.

Special Examination. Hemorrhage from the left ear and right nostril. Tenderness behind the left ear. A ragged wound in the occipital region. All the deep reflexes absent except the knee-jerks, and these vary from time to time. Suggestion of Babinski on the left. Superficial reflexes present.

Diagnosis. Fracture of the base with laceration and medullary injury. Most of the damage probably on the left.

Operation. Left subtemporal opening. Transverse fracture in the lower temporal region. The lower edge of the bone slightly deeper than the upper. No bleeding outside the dura. Some blood beneath. The surface of the brain is lacerated and protrudes somewhat. General appearance, pulse and respiration improved by operation. No drainage.

After Operation. The temperature, pulse and respiration remained steady for four hours, and then the temperature rose to 107 degrees in three hours, and the patient died. Rapid pulse. The decompression opening was never under pressure.

Autopsy. The scalp is torn and infiltrated with blood in the occipital region. From this point a fracture passes forward across the entire base and ends in the frontal fossæ. It lies to the left of the median line, passes across the outer part of the left petrous bone, and then makes for the sella turcica. It is branched in several places.

Both the frontal and temporal lobes of the brain are extensively lacerated upon their under surfaces, especially on the right. There is no special evidence of increased tension.

CASE IV. D. J. H. No. 180711. An instance of severe basal fracture with laceration and medullary involvement. Alcoholism.

The patient was a man of thirty-five years.

Immediate History. Shortly before entrance the patient was said to have fallen off an electric car. He was alcoholic at the time and was brought to the hospital unconscious.

General Examination. Deeply unconscious. Good color. Alcoholic breath. Cheyne-Stokes breathing — average rate forty-five; pulse full — rate forty-eight; temperature 94 degrees by rectum. Eye grounds negative. Blood pressure 150 mm. Nearly pure blood on lumbar puncture.

Special Examination. A lacerated wound of the occiput. No bleeding from the ears. Some bleeding from the mouth. The pupils contracted and do not react. All the deep reflexes are absent except the knee-jerks, which are faintly present. Later they were not obtainable.

Diagnosis. Fracture of the base. Severe laceration. Considerable medullary depression (compensatory vagus pulse and raised blood pressure).

Course. No operation was performed, as the patient's condition seemed necessarily fatal. He lived thirty-six hours. The temperature rose to 107 degrees and the pulse to 160 in the first twelve hours. The blood pressure fell and death took place with shallow feeble respiration, rapid pulse and gray pallor.

Autopsy. A fracture of the base extended from the region of the wound on the occiput to the right mastoid process. There was a little extradural hemorrhage in the neighborhood of the fracture, and an extensive laceration beneath both frontal and temporal lobes. The left parietal convolutions were somewhat flattened, showing that the brain had been under some pressure. There was an acute focal pneumonia, part of which might have preceded the accident.

In the type of injury described in these last two cases operation seems to be of little avail, and although it was probably indicated in the last one, I do not believe that it would have affected the result. I have thought that perhaps repeated lumbar punctures might be of advantage, or perhaps a number of small openings in the skull, through which rubber tissue wicks might be placed beneath the dura. At present, however, it does not appear that either the relief of pressure or drainage affords any relief to patients with extensive laceration. On the other hand, as operation generally requires no ether and can be done with practically no additional shock to the patient, I should say that it was a proper proceeding even in these apparently hopeless cases.

I have already discussed the more curable varieties of injury, and you may be interested to know the results of the treatment carried out very imperfectly at the Massachusetts General Hospital during the last eight months, the only specific treatment outside of surgery has been the free use of urotropin, often as much as eighty grains a day.

Of indented fractures not due to bullets there have been two. In one the scalp was torn off, and the skull driven in, without piercing the dura. In the other the left frontal lobe was deeply lacerated. Both were early cases and both recovered.

Of indented fractures from bullets there have been three. In one the wound of entrance, when seen four days after the accident, was septic and the patient died of pneumonia. In the second the patient was not brought to the hospital until two days after the shooting. He already had a frank meningitis and died. In the third the injury was fresh and the fragments of bullet were found in the torn dura. The patient recovered.

Considering these five cases together, three recovered and two died.

Of the fractures of the base, all but one of which appear to have been bursting fractures, there have been eleven. Of these two were not operated on, with one death. Of the other nine five recovered, and four died. Or, out of the eleven cases, six recovered and five died.

I have described a number of typical injuries in detail, and I hesitate to take up any more of your time with histories. I should like to call attention, however, to the number of alcoholics among the patients, and to suggest that with these men the signs of unconsciousness and medullary depression are probably much more marked than among their sober brothers. Therefore, a symptom complex which, in an alcoholic, might mean one grade of injury, probably represents a much severer grade in a sober man. At the same time, the sober man's powers of recovery are probably much greater, so that my standard is probably not so far out of the way.

I have tried to give you an idea of what I believe to be the indications for the operative treatment of injuries to the brain and its case, and I have hinted at what results may be expected. There is nothing of magic in opening the skull.

Unless there is pressure to be relieved, hemorrhages to be stopped or fluid to be drained off, there is nothing to be gained by operation. In properly selected cases, however, the following results are to be expected:

1. An edematous, swollen brain is given sufficient room so that it is not compressed. In such a case rapid recovery is probable.

2. Blood clot from ruptured meningeal vessels is removed, and hemorrhage is stopped. Here rapid recovery is to be expected.

3. Where concussion and laceration exist together, the brain is not only given more room, but blood and cerebro-spinal fluid, now no longer properly disposed of, may be drained away. Here recovery is uncertain and slow.

4. Finally, and in general, recovery in all kinds of cases is tremendously hastened, and there is some reason to believe that many of the late neuroses, epilepsy or other mental defects, so greatly dreaded by all, are done away with.

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ARTICLE XIII.

THE SURGICAL TREATMENT OF INJURIES
OF THE SPINAL COLUMN AFFECTING
THE CORD.

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DELIVERED JUNE 11, 1912.

THE SURGICAL TREATMENT OF INJURIES OF THE SPINAL COLUMN AFFECTING THE CORD.

EVEN with the subject limited to the surgical treatment of injuries of the spine affecting the cord, there was imposed upon me no easy task when I was assigned to place briefly before this section the gist of the surgical opinion of the day on this important topic.

Fortunately grave injuries of the spine are relatively uncommon. Unfortunately, for present purposes, the treatment of such injuries has not been confined to a few surgeons but has almost of necessity been in the hands of many, with the result that there has been and probably is no man or group of men who have had sufficient personal experience in this field to speak *ex cathedra*, as it were, on the question of proper treatment. There is the very widest possible divergence of opinion on the subject, one group of men asserting that operation is useless and never to be advised, another, equally honest, urging operation in every case but disagreeing as to when it should be done, and a third regarding some cases as properly operable, others as inoperable. My own experience has been too limited to warrant my drawing general conclusions from it alone. For that reason nothing new or original is to be expected from this paper in which an attempt will be made only to formulate such indications for your conduct in these cases as, in my judgment, seem best supported by the surgical sense of the present time.

Injury to the cord may take place with or without perceptible injury to the column. It is certain, however, that but few injuries of the column are unaccompanied by some degree of injury to the cord or to the nerve roots. The signs of the concomitant cord injury are usually apparent immediately but secondary cord symptoms may show themselves in certain cases after the lapse of a considerable time. That the pathologic effect of an injury may vary in extent and severity is evident. It need not be said that the treatment of all spinal injuries is determined and dominated by the presence or absence and by the character of injury to the cord, and for that reason we must review, even though hurriedly, some essential facts as to the structure of that organ and the effect of trauma on it before we can speak intelligently of treatment.

Viewed as a surgical field, the cord begins at the level of the junction of the atlas and occiput and ends at the twelfth dorsal vertebra where the cauda equina begins. Into detailing the gross anatomy of the cord there is no time to enter. You all know of its division into gray and white matter and of the general significance of each. You know, too, that the anterior nerve roots, the motor roots, go out from the anterior horn and that the posterior, the sensory roots, enter the posterior horn. Anterior nerve roots are the axones of ganglionic cells in the anterior horn; these cells are in connection with both the brain and the periphery. In passing out the axone receives its medullary sheath from the white matter of the cord but is not provided with a neurilemma until it reaches the surface of the fissure. There it becomes invested with its neurilemma (sheath of Schwann), and, thus composed of a neurone or axis cylinder, a medullary sheath and a neurilemma continues on to the muscles of the periphery. Posterior nerve roots are made up of efferent axones from the ganglionic cell bodies in the posterior root ganglia, almost all of which are situated within the inter-

vertebral foramina. From these cell bodies axones go to the peripheral sensory corpuscles also. The afferent and the efferent axones with the ganglionic cell bodies in the posterior root ganglion make up the sensory neurone. Both the afferent and efferent axones have a neurilemma except the portion within the spinal cord which is aneurilemmatous.

Under favorable conditions all axones with a neurilemma are capable of functional regeneration. Thus all the spinal nerves are capable of regeneration. The spinal cord, however, the axones of which are without neurilemmata (this is true of both the gray matter and of the columns) is entirely incapable of functional regeneration after division or destruction. The cauda equina, it must be remembered, is not included in this statement. The nerve fibers there have neurilemmata and are capable of regeneration — a fact which has a very practical application.

All the experimental evidence we have at present, if properly interpreted, goes to show that functional regeneration of the cord above the cauda equina has never taken place. To Weissman's dictum "Ganglionic cells once destroyed in the gray matter of the cord are never reproduced or replaced," John B. Murphy adds, "Ganglionic cell bodies and aneurilemmic axones are never functionally reproduced." Such clinical or experimental evidence as has been presented in support of the opposite view has not been generally regarded as convincing. Beginning growth of nerve fibers of the peripheral type has been observed in the scar tissue of an injured cord or in the uninjured dura but always of such limited extent as to be of absolutely no functional value. Improvement after suture of a severed cord has been reported in several instances but it is generally believed that in these cases there must have been some undiscovered, uninjured fibers of the cord or of nerve structures in portions of the dura remaining intact. In compression of the cord, for instance, many of the nerve fibers may lose their medullary

sheath, the naked axis cylinders remaining still capable of function. In this way, Spiller asserts, much restoration of function takes place. Restoration of function, however, does not necessarily mean regeneration nor does the attainment of perfect mechanical union of cord segments mean functional union. Some rough anatomical regeneration may take place after suture of the cord but never a functional repair.

In a cord injury the lesion may vary from the slightest to the most severe, from a mere zonal edema to total transverse destruction of a segment or segments. Secondary degeneration follows the more severe cord injuries. It is important to bear in mind that such degeneration is an effect of a cord injury and not the cause of compression symptoms. Of itself it probably causes no symptoms. (Spiller.) If the nerve fibers are severely injured, degeneration occurs whether compression is immediately removed or not, whether immediate suture is done or not. Removal of pressure will not cause already destroyed or degenerated fibers to regenerate.

All these above-mentioned facts are fundamental and have a practical bearing on the question of the treatment of injury of the cord, the various types of which we are now to consider. As good a history as possible of the accident should always be obtained. It may throw important light on the kind and on the degree of severity of the resulting injury.

CONCUSSION OF THE CORD; CONTUSION OF THE CORD; HEMORRHAGE.

Concussion of the Cord. The term "spinal concussion" is not recognized by all surgeons. It is true that it does not represent a morbid entity but the term is used to designate a condition in which the function of the spinal cord is impaired or interrupted by an injury which does not produce

gross anatomic changes. The question of its existence or nonexistence is of academic interest only. It is evident that it has no distinguishing symptoms and hence is of no clinical interest.

Contusion of the Cord. True contusion of the spinal cord is well recognized. The cord is one of the best protected structures in the body and, as a rule, great violence is necessary to do it injury without fracture or dislocation of the vertebral column. It is known, however, that direct violence applied to the vertebral column, as, for instance, by a fall on the back, may give rise to contusion of the cord by causing it to be thrown forward and backward with greater or less violence within the canal — the so-called “indirect contusion” of the French. Either the white or the gray matter or both may be affected and the resulting lesion may vary from a slight and transient one to a severe and partially permanent one. There may be a limited traumatic zonal inflammation of the cord, a separation of the fibers by blood or exudate forcing them apart with a temporary suspension of their function but without the destruction of the axones. On the other hand, there may be destruction of some of the fibers of the cord.

The cord may also be contused by the direct, immediate trauma of displaced bone (spinal arch or body) — the “direct contusion” of the French. Here, as in the indirect form, the extent and the degree of the resultant injury may vary but it is apparent that the direct variety is much more apt to do the greater damage.

Hemorrhage. Hemorrhage within the canal (hematorrachis) or cord may exist of itself or in conjunction with contusion or other injuries. It may be extradural, intradural, or intramedullary (hematomyelia).

Extradural and intradural hemorrhages are usually of themselves not of great moment. Occasionally the effusion of blood is of sufficient amount to produce per se symptoms

of pressure which come on gradually and progressively and, as a rule, disappear in from four to six weeks. The extradural is the more frequent form. The intradural may be diagnosed and occasionally even relieved by a lumbar puncture. The symptoms of both are usually transient; neither form is often of such amount as to cause of itself important symptoms. When intraspinal hemorrhage (hematorrachis) is severe, it is usually the accompaniment of much more important and graver spinal cord injury and its treatment is involved in that of the more serious trouble.

Hematomyelia. This may be central or scattered. The latter form is entirely impossible of diagnosis and is of no clinical importance. The central or usual form is almost always seen in the region of the fourth, fifth and sixth cervical vertebræ (occasionally in the upper dorsal region) and in traumatic cases is due to overflexion of the spine. (Thorburn.) The gray matter of the cord is softer, of looser structure and less resistant than the surrounding white matter and, though better protected, is really more susceptible to injury. The result of hemorrhage into it is the permanent destruction of a certain number of nerve cells and a varying degree of transient pressure on the structures in the white matter. The blood clot and destroyed cells are gradually absorbed but a cavity is left in the gray matter and, hence, even in cases of recovery, there is always some weakness remaining.

I believe that the occurrence of contusions of the cord and of the intraspinal hemorrhages as sole entities is rather uncommon. That they may occur as such, however, has been clinically proven. Thus regarded, what are the indications for their treatment? In neither kind of hemorrhage is there any indication for operative interference other than the presence of the signs of gradually increasing intraspinal pressure. Given those signs in extradural hemorrhage laminectomy should be done for the purpose of stopping the

flow of blood or of giving exit to it and in that way relieving pressure. If a period of noninterference with respiration is followed by respiratory embarrassment, then the indications for interference are plain (Fowler), though to my mind the outcome in such an event even with operation is practically hopeless. In subdural hemorrhage with symptoms of increasing pressure lumbar puncture is indicated and, if it does not relieve, laminectomy should be done.

In hematomyelia operation cannot be of avail. The damage to the gray matter is instantaneously destructive and such pressure as exists in the white matter in the tracts will be relieved by the absorption of the central clot. Fowler advises early operation in all cases of hematomyelia but the reason for this advice is by no means apparent.

Operative interference is not indicated in cases of simple contusion of the cord. To these cases time will bring all possible recovery. Immediate and even early diagnosis in these cases of uncomplicated contusion and of hemorrhage (in or upon the cord) is manifestly difficult. Hematomyelia gives, perhaps, the most marked clinical syndrome but even there operation is not indicated. These conditions are usually seen as concomitants or complications of the more severe spinal injuries — the fracture dislocations. It is this type of injury that the surgeon usually has to face and consequently it is just here that he wants to know what course to follow. Shall he operate or shall he employ less radical measures?

For the most part surgeons are agreed that in complete transverse lesions of the cord operation is contraindicated, for reasons previously mentioned in this paper. The contention of those advising operation in all cases of severe spinal injury has been that one cannot tell from clinical signs and symptoms alone just what has happened to the cord. Cases that have given every accepted sign of complete division of the cord have on operation shown no totally de-

structive cord lesion or else some direct mechanical pressure that could be relieved. In other words, we can be certain of the exact nature of the injury only through laminectomy which in itself is said to be easy of accomplishment and harmless. With this phase of the question I shall deal later.

Now, if there are signs and symptoms that will indicate for a certainty whether a cord injury is complete or partial, in our recognition of them lies the means for deciding for or against operation in a given case. What are the generally accepted signs first of a completely destructive and then of a partially destructive cord lesion?

Signs of a Complete Cord Lesion. Complete motor paralysis of those parts of the body supplied by nerves leaving the cord below the level of the cord lesion; complete loss of muscular tone — a flaccid paralysis; complete and parallel vasomotor paralysis (increased surface warmth, marked sweating, anemia of viscera, priapism, etc.); absolute loss of the deep tendon reflexes (the plantar, perhaps, excepted); a corresponding area of complete absence of sensation of all kinds with a sharply defined upward segmental level; absolute loss of all form of motor and sensory nerve irritability over these areas; absence of pain; absence of variation in the symptoms.

Signs of a Partial Cord Lesion. The motor paralysis is not absolute; it may be slight or almost complete; it may affect an isolated group or whole groups of muscles; the quality of the paralysis may vary from complete spasmodic paralysis to flaccid paralysis; the paralysis of the bladder and rectum may be incomplete or even entirely absent; the vasomotor paralysis may not parallel the other forms; the sensory paralysis may not be absolute and it may not parallel the motor paralysis; some forms of sensibility (pain, for instance) may be absent while others (heat, contact) may be present; evidences of sensitive irritability (hyperesthesia, darting pains, formication, etc.) may be seen; the reflexes,

still present, may be intact, diminished, or even exaggerated. Early improvement is usually seen.

It would seem from the two paragraphs immediately above that the diagnosis between the two forms should be a relatively easy matter. Experience, however, has shown that the diagnostic line is not an absolute one. Definite absence of the deep reflexes (the Bastian-Bruns law) has been the one most striking feature of total lesions and it may safely be said that in practically all cases its worth is absolute. Kocher, whose experience and judgment cannot be questioned, said in 1909 that he had never been deceived in this sign. However, while the presence of these reflexes makes the absence of a total lesion certain, their absence cannot be always and in every case regarded as absolute proof of a total lesion unless that absence is permanent. A temporary loss of these reflexes (even up to eight days) has been observed in numerous cases of partial lesion.

With this in mind Sencert and Auvray, of Nancy, with their colleagues in physiology and histology undertook some experimental work with the hope of defining still more certainly the diagnostic line between partial and total lesions. Their results were reported to the French Congress of Surgeons in 1909. What they added to our knowledge of the subject may be summed up about as follows: In a total cord lesion both the excitability and the conductivity of the nerves originating below the level of the injury are abolished and their absence is indicated by the early appearance of the reaction of degeneration of the nerves; in partial lesions, on the other hand, only the conductivity is interfered with, the excitability being little if at all disturbed, as is shown by the nonappearance of the reaction of degeneration. Such opportunities, as the authors had of applying the results of the experimental work to clinical material, proved its value. The disadvantage of the test lies in the fact that only in the hands of a trained neurologist would it be of value. The

average surgeon would have neither the instruments nor the skill requisite for making the tests.

But even without the aid of these last mentioned signs one may assume, with a fair degree of certainty, the presence of a transverse lesion of the cord when there is a complete immediate annular paralysis of both motion and sensation below the line of fracture and when, at the same time, the deep reflexes are abolished.

If a transverse lesion puts a case out of the realm of our present-day surgery, our consideration must be turned to the treatment of cases of partial lesions of the cord.

In this connection it is worth while to digress momentarily and to view some recent experimental work by Allen. In cases of cessation of function of the cord in which the latter has not been literally severed we must assume that either there is destruction of the axis cylinders (in the restoration of which we can in no way aid) or else "there is a serous or hemorrhagic outpouring into the cord tissues which, by its pressure and chemical activity, inhibits temporarily all conduction function or destroys permanently the spinal cord." Now, in these second conditions Allen believes there may be a chance of affording relief. After artificially producing injury to the spinal cord of a dog sufficiently severe to give all symptoms of a transverse lesion he has done a laminectomy on the animal under ether and made median longitudinal incisions with a fine knife through the injured areas, thus instituting spinal cord drainage, a sort of spinal cord decompression. Allen's results in these cases, compared with those in a control series in which the median longitudinal incisions were not made, were quite wonderful, since a complete restoration of motor power was obtained. The median longitudinal incision caused no symptoms worthy of note. Allen is not yet ready to apply this procedure to man but his tentative conclusions, which I quote, are most interesting. "In cases of fracture dislocation of the spinal column in the

human subject in which there exists the symptom picture of transverse lesion of the spinal cord, it were well to perform the operation of laminectomy at the earliest possible moment and, if the cord be not completely severed, to make a median longitudinal incision through the area of impact by means of a fine canaliculus knife in order to drain the injured tissue of the products of edema and hemorrhage."

I believe there is not yet sufficient reason for indicating this as a routine measure in injuries of the spinal cord in human beings. But Allen's work is most promising and it may open a wide field for useful operative work in the treatment of conditions which up to the present have responded unsatisfactorily to our efforts for their relief.

Clinically, partial lesion of the cord may be separated into two divisions: 1. Cases in which the diagnosis of partial lesion is certain. 2. Cases in which there is doubt as to whether the lesion is partial or total.

1. *Cases in which the Diagnosis of Partial Lesion is Certain.*

If our eyes and our fingers fail to find a deformity of the vertebral column and if the radiographic examination confirms us in this finding, then it is fair to assume that the cord lesion is due to a contusion, to a hematomyelia or to a hematorrachis. A clinical distinction between them is usually difficult and often impossible. Surgical intervention is not indicated. Nature will cure more or less completely. As far as our present knowledge serves us, operation will not aid. In exceptional instances, after a progressive improvement in a case, betterment may cease or even retrogression begin (due to organizing blood clot, to adhesions or to incomplete resorption of the hematoma); then a secondary operation may be considered. It is to be considered also in cases which show no spontaneous improvement.

If a spinal deformity is found either on routine examination or through the use of the x-ray, active treatment should be instituted promptly. Active treatment is not always

synonymous with operative treatment. In unilateral or bilateral luxation of a cervical vertebra manual reduction should be tried and, that failing, careful traction and extension under an anesthetic;* if these measures are unavailing and symptoms of pressure continue, laminectomy is indicated.

In isolated, displaced and depressed fractures of the spinal arches with pressure symptoms, laminectomy should always be done and done promptly.

In fracture of the vertebral bodies operation should not be our first consideration. One should first try the effect of position (rest on a firm bed with proper supports beneath the injured point, etc.), of traction with or without counter-extension, of "gravity reduction," etc. If under such treatment the motor or sensory paralysis remains stationary or increases, than either the deformity of the fracture has not been reduced or an exuberant callus is pressing on the cord. Laminectomy is the only means of relief.

In fractures in the mid-cervical region, where there is danger of pressure on the fourth cervical segment, immediate operation is indicated.

In fracture dislocations with symptoms pointing to a partial medullary lesion immediate operation should be the rule. I believe that it is less dangerous than attempts at bloodless reduction and that it will prove effectual in more cases.

2. *Cases in which there is Doubt as to whether the Lesion is Total or Partial.* In these cases wait, as a rule. If by reason of the high situation of a deformity, life is directly and immediately threatened, operation should be done in the hope of warding off the immediately impending danger.

In other cases treat the patient tentatively and try in every way to distinguish between a total and a partial lesion. If in from four to five days the existence of a partial

* Note Dr. Walton's comment in the discussion of the article, page 259.

lesion is fairly certain, operation is to be considered. Kocher sees no reason for immediate hurry and believes that late operation may be done with benefit to the patient even if pressure has continued for a long time. If, on the other hand, a transverse lesion is indicated, do not operate.

From our present knowledge it is probable that if in the future operation is done in complete transverse lesions of the cord, it will be undertaken only with the idea of making a possible anastomosis of nerve roots above and below the lesion. We do not as yet know just how much can be accomplished by such operations nor to just what fields they may be applied.

In lesions of the cauda equina, no matter how great the degree of severity, laminectomy should be done and suture of the severed cords attempted. Here we may hope for good results, since the fibers in the cauda equina have neurilemmata and consequently complete regeneration is possible.

A general word about injuries to the spinal column may not be amiss here. Because a patient with injury to the column shows no immediate sign of cord injury, it is not to be assumed that symptoms and even crippling symptoms of pressure on the cord or nerve roots may not appear later. It is our duty to examine with care each case of back injury, to insist that a radiographic examination be made and to see to it that suitable treatment be instituted and continued. The x-ray has shown many unexpected bone lesions in these cases.

I shall not go into detail as to the technic of operations on the spinal canal and cord. In traumatic surgery a simple laminectomy is to be preferred to the various osteoplastic operations. Bear in mind the tendency to place the lesion lower than it really is and the consequent danger of operating at too low a level. The dura should always be opened. One often sees the statement that laminectomy is a harmless operation; furthermore, those who advise operative

interference as a rule in spinal cord injuries quote this assertion in support of their contention. I am not sure that the assertion states the fact. Kocher and Harvey Cushing, both masters in neurologic surgery, consider laminectomy anything but a harmless operation and are most conservative in advising its use. Spiller has seen harm result from it. Surely in most cases it must add insult to an already damaged cord. Do not regard the operation as innocuous or as one often indicated as an exploratory measure. If there are indications for undertaking it, let it be done with all possible gentleness and with special attention to hemostasis. The baneful effect of hemorrhage on the tissues of the cord and of other nerve structures is well recognized and must be borne in mind.

It is only fair to note here that both Heidenhain and Robertson have done laminectomy under purely local anesthesia.

The greatest care in handling the unfortunate victims of cord injuries must be exercised both before and after operation. If transportation or moving is necessary it should be conducted with every precaution. After a laminectomy immobilization of the spine is necessary. Sudden deaths have resulted from failure to provide it. Cotton and Blanchard believe that "in all cases in which laminectomy seems inadvisable and in a large part of the cases in which it has been done, we should place thick heavy pads at either side of the spine below the break." Gravity is thus made use of in the production and maintenance of proper position.

Two important factors in the after care of injuries to the spinal cord are the prevention of bed sores, if possible, and the avoidance of infection of the bladder. It will require nursing of the most careful kind to prevent bed sores; sometimes prevention is impossible. It is only rarely that the treatment and long continued catheterization of the bladder will not result in a serious and often fatal cystitis. Cushing has gone so far as to advise immediate suprapubic

cystostomy in cases of severe injury to the cord. In his experience such a procedure increases the comfort of the patient and lessens very much the danger of renal infection. The choice, however, cannot be called comforting.

I am quite aware that my views will probably not be in agreement with those of many present. I know, too, that cases may, and will be, quoted in which great improvement has followed laminectomy in apparently hopeless cases of spinal cord injury. On the other hand, we have all seen really remarkable recoveries in unoperated cases and some unfortunate and many indifferent results in cases upon which operation has been done. It may and has been claimed that a certain knowledge of intraspinal conditions can be had only through an open operation and yet Spiller tells us that a cord exposed at operation may appear to have escaped injury and still have such internal changes as to be absolutely and hopelessly functionless. Whether to operate or not is often a puzzling question and many circumstances come into consideration in making a decision. De Quervain, who reported a most careful study of 218 operative cases collected from surgeons the world over, puts so well and with so good reason the average opinion (so to speak) of present day surgery that I shall quote in part his conclusions.

“Neither extradural hemorrhage nor intradural hematoma provide, as a general rule, operative indications unless compression of the mid part of the cervical cord by a hematoma without concomitant contusion of the cord (a diagnosis difficult to make) imperils the life of the patient through progressive respiratory trouble. Late operation is indicated by incomplete resorption of the hematoma.

Operation must be proscribed in cases where the symptoms speak in favor of hematomyelia.

Early operation is indicated when the nervous troubles can be attributed after clinical examination to the fracture of an arch.

An early intervention may be useful, without presenting, however, much chance of success, when in a dislocated fracture attempts at bloodless reduction have failed and the patient shows symptoms of a partial lesion (favorable results in cases of compression between body and arch but quite useless in cases of contusion).

Late intervention is indicated if in the prementioned cases early intervention has not taken place and the nerve symptoms have not improved spontaneously or if an ulterior aggravation of the symptoms should happen in a case of partial lesion (compression by a callus, especially in cases of fracture by compression)."

In surgery of the brain and cord we face a situation beset with difficulties and bound to be accompanied by disappointment. We have to do with tissues highly specialized, highly organized and practically incapable of regeneration, with tissues which control the most important bodily functions. In the surgery of other structures (as, for instance, the intraabdominal organs) many of our unintentional errors, unfortunately necessary in accomplishing advance in any surgical field, may be later fully or partially corrected; in this field, however, an error made or damage done is irreparable; hence our progress should be slow and careful. The outlook for great advance, I think, is not any too promising and I say this not because I impute any lack of skill or want of willingness to the profession, but because I believe that the innate difficulties presented by the nature and composition of the structures in question are insurmountable.

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DISCUSSION OF THE THREE PRECEDING PAPERS.

DR. HOMER GAGE, Worcester: In discussing these three very valuable, very interesting, papers, upon the presentation of which I think we are to be very much congratulated, the first and most striking feature, it seems to me, is the conservatism which has been displayed by all three readers. It is so unanimous that it might seem as if it had been pre-arranged, but it was not. It is a rather remarkable fact, I think, that these three men, working under entirely different conditions, and in the face of the modern tendency to operate pretty freely, have all shown conservatism.

I won't take up your time by discussing these papers in detail. There are, however, one or two points that strike me as of especial interest; and, first, in Dr. Taylor's paper on traumatic injuries from the viewpoint of a neurologist, what is of course of particular interest to all surgeons, on account of the legal problems that are often involved, is that traumatic neurosis does not mean shamming, does not mean purposeful neurosis, does not mean a chance to take advantage of ones employers, as in the case of the fireman, to which he has referred and it is well to be reminded that very frequently when there is no question of litigation, the after results are exceedingly distressing and often permanent.

In the paper on injuries to the head, it is rather interesting to see that the old question of the treatment of simple depressed fractures does not have to be referred to at all. Whenever a depressed fracture of the skull is demonstrated, as spoken of in Dr. Homans' paper, it must be operated upon

and the depression must be elevated whether that fracture is simple or compound.

Another matter which is interesting is the reference to concussion, and it seems to me that Dr. Homans has stated that very well when he speaks of a blow on the head that may not injure the cranium at all but may inflict serious damage on the brain underneath, and yet a damage that may be temporary. In other words, that the damage is due to edema or hemorrhage causing a slight or temporary compression, that concussion has a definite pathology and is not the mere effect of changing the molecules of the brain, as we formerly believed.

And in Dr. Bottomley's paper he has brought out very clearly that the absolutely essential thing is that the cord cannot regenerate; there is no neurilemma. If the cord is damaged, it cannot be regenerated — the cord cannot be restored. The most important factor in determining the indications for an operation is not the exact way in which the injury has been inflicted or the objective signs of that injury, but the progression of the symptoms, both in the head and in the cord. And the object, of course, is, as has been said, to relieve pressure, to stop hemorrhage and to establish drainage. These are three important factors, and are to be taken as indications for an operation only when the progress of the symptoms demands it; and, as in some of Dr. Homans' cases, it may be necessary to watch for only a few hours before determining the question finally; and in others for many days before performing the secondary operation on the cord.

It seems to me that these are very valuable papers, and I hope the discussion will be a free one.

DR. J. B. BLAKE, Boston: I will speak very briefly on Dr. Bottomley's excellent paper on laminectomy. It is proper at this time to recall the pioneer work of the late Dr. Munro, who, fifteen or twenty years ago, brought to the attention of the younger men the fact that laminectomy might be done with advantage in certain traumatic affections of the spinal cord. He felt even at that time, before the operation was generally practiced, that it might be done much more frequently than was ordinarily supposed. He

emphasized, however, the fact that the operation should be attempted only at the hands of a competent surgeon. In such hands the operation is not necessarily one of extreme technical difficulty; certainly not more severe than some cases of nephrectomy and some operations for gallstones, cancer of the rectum, etc.

Dr. Munro also emphasized a fact which it is impossible to escape — that neither the surgeon nor the neurologist can make a correct diagnosis of complete and permanent destruction of the cord in every case. There is a considerable margin of error; and if this be true, it at once removes a certain number of cases from the class that must not be operated. There are cases of cord injury which, although apparently completely destructive, are actually partial with pressure so great, that if it is not relieved in a comparatively short time (48 hours), the loss of function may become permanent and irremediable.

At the Neurologists' meeting here and at the meeting of the American Medical Association in Atlantic City, I had an opportunity to talk with a number of prominent neurologists and surgeons on this subject, feeling that informal conversation may often modify considerably views expressed in print. I was struck with the very large number of prominent neurologists who were in favor of operation, who felt that laminectomy was justified in a considerable percentage of cases. I found a greater number of neurologists of this opinion than in a corresponding number of surgeons; out of ten or a dozen equally skilled, the neurologists rather than the surgeons were more radical. It was noticeable that the old saying did not apply, that surgeons rush in where the neurologist would not dare to tread. It is apparent that the surgeons and neurologists still have widely different opinions on the subject, and that the ultimate solution of the questions at issue is not yet at hand; indeed the problem seems to excite as many different opinions now as in the beginning.

In this connection Dr. Allen's admirable experimental work on traumatic injuries of the spinal cord should be again mentioned, an investigation incidentally, which has not been carried to a conclusion owing to the activities of certain antivivisectionists. If we can reach the decision

that operation is permissible in all cases in which the complete destruction of the cord is not present, we must choose each case on its merits. It is essential to have a competent surgeon and a well-trained anesthetist. I believe that the patient should be put on the table and etherized in the position in which he is to be operated, that is, lying prone face downward. It is desirable to use the table devised by Dr. Harvey Cushing, but if this is not at hand, sand bags may be placed under each shoulder in such a way as to facilitate breathing. If this be done, interference with respiration is minimized, and shock diminished; the tongue does not tend to fall backward and mucus is less likely to be inhaled. The spinous processes can themselves be attacked by the use of small Rongeur forceps such as are used in the mastoid operations. It is essential to eliminate mallets and saws, and particular care should be taken to avoid injury to the dura. The dura should always be opened. I cannot help thinking that pressure to be relieved should be relieved as early as possible. Hemorrhage may be controlled by hot packing; the wound should be closed without drainage. I have not found that extension was necessary. In my experience, the cases have gone unexpectedly well in their post operative course. Unless, therefore, the lesions of the cord are absolutely irreparable, cases may be considered for laminectomy, immediate or intermediate rather than late, in order that the complications of secondary contractions may be avoided.

DR. R. H. SEELYE, Springfield: I, too, have enjoyed these papers very much and have been very much interested. I realize the limitation of my experience in speaking on these subjects; I have not seen a sufficient number of these cases to feel competent to pass a definite opinion as to the proper course of procedure, but I wish to speak for conservatism as the readers have. It seems to me that in the cases of brain injury, conservatism is the important thing. We have to do with pressure from bone, hemorrhage and edema. For the relief of these we should be conservative in time particularly. It seems to me that there should be no haste in dealing with these conditions. In very many instances bone pressure

can be relieved at a later date, hemorrhage will stop spontaneously, and after clotting has occurred can be relieved better perhaps than if it is done too early, and edema will take care of itself. Such a condition might be illustrated by a case recently in my experience: A man fell from a street car; he was unconscious and paralyzed, but not quite completely, on the right side of his body. After four days without improvement, he was operated upon, and the brain was found bulging into the wound and not pulsating (and this condition of nonpulsation of the brain is one of the utmost gravity). A large amount of free blood and some clot was removed and blood kept on oozing from the base. It was not possible to stop it, although the pressure in the brain was so relieved that the brain pulsated and we felt hopeful that something might be accomplished. Although some of his symptoms improved, he died a few days after. The reason I mention this is that it is my feeling that perhaps we should have waited a few days longer for the hemorrhage to stop and the blood to clot in order that decompression might be permanent and not followed by a refilling of the cranial cavity with blood.

Cases of extensive fracture with edema and hemorrhage will in some instances get well themselves; more frequently they will die. It is a good deal of a question in my mind whether an operation will relieve many of these cases. How much decompression relieves them is a difficult question to decide. I wonder whether it would be advisable in any of these cases, — and I think it has been done in some instances, — to do a lumbar puncture to relieve the intracranial pressure. Cases of local injury are of course much more satisfactory and much easier to treat; and these cases, too, it seems to me, should be delayed until we get definite local symptoms, until the general symptoms have disappeared. A case comes into my mind that illustrates this point: A man was thrown by an automobile going at a rapid rate and was admitted to the hospital with loss of consciousness. This disappeared. He became conscious but not lucid, his pulse was low, he vomited and complained of pain in one side of his head. These were the only symptoms that he presented. After five days of this condition we operated, and were fortunate enough to come down upon a large clot, which was

removed, and the patient made a satisfactory recovery. It is an argument for waiting until the clot forms.

In cases of injuries to the spine, I can only add a word in favor of conservatism. I think we should be very careful in selecting the cases which we consider it is proper to operate upon.

DR. CHANNING C. SIMMONS, Boston: There is one form of what may be termed traumatic head injuries which Dr. Homans' paper does not touch upon, namely, intracranial cerebral hemorrhage in the new born. These cases are extremely rare and are often overlooked. On the other hand, they are important as if unrecognized and untreated death ensues in a few days, or if the child does survive, it is very apt to show signs of cerebral irritation in later life. Spastic paraplegia follows in many cases while others have permanent paralyses, epilepsy or show retarded mental development.

As the result of a difficult or prolonged labor, usually in elderly primiparæ, the head of the child is so compressed at birth that several of the veins running over the cortex of the brain under the dura and emptying into the longitudinal sinus near the anterior fontanelle are ruptured by the overriding of the bones of the skull. Rupture may also occur from the increased cerebral tension in asphyxia. As a result of this a subdural hemorrhage takes place. The extravasation is usually situated over the cortex near the motor areas but may extend over the whole hemisphere and under the tentorium. It may be unilateral but is often bilateral although greater on one side.

The symptoms may be immediate, — appearing a few hours after birth, — or delayed, and not make their appearance for several days. They are primarily those of cerebral pressure and irritation. In the typical case the child immediately after birth seems normal in every respect but at the end of several hours shows difficulty in breathing and becomes cyanotic. There is usually stupor, inability in nursing and a rapid pulse. There may be twitching of the extremities due to cerebral irritation, or even regular convulsions. The fontanelle is tense and bulging. In other cases there are no localizing irritative symptoms, such as

twitching or spasticity of a limb or facial paralysis, the child only appearing apathetic and being unable to nurse. In the delayed cases the symptoms are the same but do not appear for several days. Lumbar puncture, as in other subdural hemorrhages, reveals bloody cerebrospinal fluid.

The diagnosis is usually easy but at times is difficult as all definite signs may be lacking. It is made on the departure of the child's status from normal, the tense fontanelle, and the presence of blood in the cerebrospinal fluid as shown by lumbar puncture. When irritative symptoms are present, such as the twitching of an arm or leg, it is possible to determine the side on which the chief hemorrhage has occurred but these symptoms are often absent.

The results of the operative treatment have been on the whole, up to the present time, poor but considering the absolute hopelessness of the condition, as regards cure, by any other method of treatment operation should be strongly urged and I believe with our present knowledge will give a large per cent of cures. In a recent review of the literature I could find the reports of fourteen cases only treated by operation. Nine of these were operated upon by Cushing with four recoveries. In the other five the Cushing operation was done but all were unsuccessful. Cushing's operation consists in reflecting a bone flap consisting of nearly the entire parietal bone, opening the dura and washing the clot away. It is a major operation but less difficult than in the adult as the thin bone of the child's skull can easily be divided with scissors. If the hemorrhage is bilateral the operation has to be done on both sides.

I have had the opportunity to operate on two of these cases, which I reported last winter (Boston Med. and Surg. Jour., Jan. 11, 1912), both of which were successful. The operation performed differed from that of Cushing. It was practically a decompression done over the seat of injury and analogous to that performed in any case of cerebral compression from subdural hemorrhage. It was simple, easy of execution, and, apparently from the results, justified. It consisted in making a transverse incision over the coronal suture three or four inches long passing over the anterior fontanelle. The skull was then opened with a knife through the soft suture $1\frac{1}{2}$ inches from the median line to avoid the

longitudinal sinus, and the dura incised with the escape of dark blood in both cases and the immediate lowering of the intracranial tension. Both cases were done practically without an anesthetic as the babies were comatose but after the relief of tension they became conscious and cried. The symptoms were relieved and did not return. Convalescence was uneventful and the children have developed normally. One is now fifteen months old.

In these two cases the opening made in the skull was small but in future I should be inclined to enlarge it with rongeur forceps to get a better view of the hemispheres. The bone flap operation of Cushing can be performed later if it is deemed advisable.

DR. G. L. WALTON, Boston: We have heard the last word regarding the facts. The last word regarding the conclusions to be drawn from these facts will, of course, never be heard. These conclusions will vary with the experience of the observer, perhaps somewhat with his temperament, certainly with the variations of the individual cases; for however we may group them no two cases will be just alike. It is hard to find anything in these papers to comment on except favorably, but yet where the readers diverge in their conclusions there is room for choice. There seemed to be little variance of opinion among them except in minor points. For example, the impression was left that Dr. Homans was perhaps rather less conservative than either of the other readers regarding the question of surgical intervention in case there was no evidence of bone depression or of increasing pressure; in other words, that he would be rather more free to operate to relieve the swelling of a simple bruise of the soft parts in order at least to lessen the severity and duration of the symptoms produced by the edema. I should be inclined on this point to agree with the other readers that whatever advantage might be gained by such operation was more than offset by the objections of operation, objections which Dr. Bottomley treated with due respect, as behooves one who has had practical experience with them. On the other hand, in case we have diagnosticated increasing hem-

orrhage in an accessible region, operation cannot be undertaken too quickly, an opinion in which I am sure Dr. Seelye concurs, and his suggestion of waiting for the hemorrhage to clot could not have included such a hemorrhage as this. With regard to Dr. Seelye's suggestion concerning lumbar puncture, I understand that this procedure is coming more and more into vogue for the mere relief of pressure, for example, in the course of operations for brain tumor when the cerebral pressure becomes sufficient to embarrass the operator. While one should be extremely cautious regarding this sudden relief of pressure in case of tumor in the cerebellum or pons, I do not believe that there is any danger in lumbar puncture unless some such condition exists.

With regard to cervical dislocation, I gather that Dr. Bottomley advises manipulation without ether and in case this fails, traction and extension under ether. I should not attempt reduction of such a dislocation at all without ether and after etherization should not use extension, which hinders rather than helps the reduction. The manipulation is a matter of leverage. If the left articular process, for example, has slipped over and dropped into the intervertebral notch below, the head will be rotated to the right and bent to the left. The movement for reduction, which should always be done in the sitting posture, and under ether, is the movement which will disengage this articular process, namely, first bending the head to the right and backward, that is, "southeast," then rotating back to place.

DR. F. B. LUND, Boston: I have been very much interested in these papers and have liked the conservative ideas as have the other speakers. I have grown to feel, as I have seen an increasing number of these cases, that the progression of the symptoms is what we must go on. If a patient can be roused, and as we watch him from hour to hour he is a little harder to rouse, it is a strong indication for operation; if he is roused more easily and moves more easily, then the indications for nonoperation are usually equally distinct. We must determine each case on its merits; sometimes by local signs, and sometimes by general symptoms.

I have found the fact to be true, to which Dr. Walton called our attention in a paper some years ago, that the injury to the skull caused by a fall from a height striking on the hard ground is more serious than that caused by the falling of objects on the head. Where the head, itself, strikes on the ground the skull is cracked like a melon and we have found that an insignificant crack beginning at the vertex will run down beneath the skull widening as it runs and will very likely involve the middle meningeal artery or cause serious injury to the other structures at the base of the skull.

I do not agree with Dr. Seelye that we should wait for the formation of a clot. If hemorrhage is going on, the patient may die very soon. In reference to the choice of the point for operation we have sometimes to depend upon local injuries, bruises, contusions, etc., and sometimes upon the general symptoms. Early this year I saw a man six hours after a fall from his team, unconscious, with general signs pointing to fracture of the base. As an indication as to where to open the skull one had a bruise of the left temporal region. We operated in this region, found the clot and the man recovered.

A short time later I happened to be present when a man was hit by an automobile and fell down, hitting his head. He became unconscious but partially regained consciousness so that we were able to walk him to an automobile and he walked with assistance into a hospital. In a few hours his pulse went down to 40; he became completely unconscious and a paralysis of the left side of the body with stertorous respiration and cyanosis ensued. Although what bruise there was was on the left side of his head we decompressed on the right side and found a very large extradural clot in the parietal occipital fossa. This was removed and the dura did not at once come up to the level of the skull and the patient did not recover.

In regard to laminectomy for fractured spine, if we can determine the cases in which the cord is not irreparably damaged, we ought to do it. I agree with Dr. Bottomley that in certain cases damage to the cord during the laminectomy may take place and I have seen such injuries. Perhaps the cord was irreparably damaged before but at any rate it is not pleasant to see it damaged at the operation.

It is very important, as the writer has said, to be very careful about moving the patient after operation as a fracture dislocation may be easily reproduced by careless moving of an unconscious patient and the removal of the lamina certainly does not increase the stability of the spinal column at the injured point. I can also confirm what Dr. Walton has said, that it is easy to reduce unilateral dislocation of the surgical vertebræ and the fact that it is more important to perform these manipulations intelligently than to make strong extension. In a recent case, I was successful by manipulation, extension having failed. I consider Dr. Walton's contribution very important.

ARTICLE XIV.

INDICATIONS FOR THE MAJOR OBSTETRICAL OPERATIONS.

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INDICATIONS FOR THE MAJOR OBSTETRICAL OPERATIONS.

THE greatest advance in obstetrics in the last few years has been in the realization that obstetrics is properly a special branch of surgery, and that the application of modern surgical methods to the solving of obstetric problems has resulted in a marked change in the attitude of the obstetrician toward his patients. Before the development of asepsis placed abdominal surgery on a firm basis, the problem which the obstetrician had to solve was whether in a given case any method could be devised by which the individual patient could be delivered per vaginam, irrespective of the damage to her soft parts or to the child. This question was often a difficult one to answer, since the conditions present in the individual case were often such as to render the ordinary obstetric operations of doubtful outcome, and the results were, therefore, often unsatisfactory. The lives of many women and the health of many more were sacrificed in the attempt to solve the problem with the means at our command, and the fetal life received comparatively little attention, and deservedly so, as compared with the maternal life. The demonstration of the safety of modern surgery and its application to obstetrics has solved the problem for us, and we can say to-day that practically every healthy woman can be safely delivered, with due regard to her after health and the well-being of her child, provided the conditions which call for a departure from the routine practice are discovered either before labor or early in labor, so that she can be placed under proper conditions to receive the care she needs.

The question which we now have to answer is not, whether a given patient can be delivered by any method, but, by what method can delivery be most safely accomplished in the given case? This change in our point of view has brought about a great change in the methods of conducting an obstetric practice, and one which will grow more marked as time goes on. Under the old practice our choice of operations was limited, and nature was considered supreme, each patient being allowed to go into labor irrespective of the conditions present, and difficulties were met when they arose as efficiently as possible under the circumstances, the patient being studied little or not at all before labor began. Under modern conditions each patient is regarded as presenting a problem to be studied, and it is recognized that the riddle must be solved before labor begins if the best results are to be obtained. In other words prophylaxis is assuming a greater importance in obstetric work than ever before. Every patient must now be studied from a new standpoint and the question to be answered to-day is this: What method of delivery offers the least danger to life and health for the mother combined with the greatest safety for the child?

This change in our viewpoint has been brought about by the introduction into obstetric work of the so-called major operations, by which we mean abdominal Cesarean section, followed or not by removal of the uterus according to the indications present, and enlargement of the pelvic canal by pubiotomy, followed by one of the ordinary obstetric operations; or, in other words, the performance of a cutting operation for delivery of the child instead of dragging it through the pelvis by brute force.

CESAREAN SECTION.

Before discussing the indications for an abdominal delivery it seems best to consider carefully the conditions

which render abdominal section a safe or unsafe procedure, since the presence of certain conditions is recognized as converting what should be a safe operation into one too dangerous to be advised, and as the primary object of modern obstetrics is to preserve the fetal life without unduly jeopardizing the life or health of the mother, all conditions which definitely increase the danger to the mother should be considered as relative contra-indications to Cesarean section.

Under modern conditions an abdominal section on an uninfected patient is so safe a procedure that in general surgery an exploratory operation may be properly recommended for diagnostic purposes only, but any failure in technique transforms what should be a safe procedure into one of the greatest danger. For this reason Cesarean section is never to be advised when any other operation is possible unless the surroundings are such as to allow of proper asepsis at the time of operation. If the slightest suspicion of uterine infection is present Cesarean section is absolutely contra-indicated, unless no other means of delivery is possible, since the opening of a septic uterus into the peritoneal cavity, particularly if followed by suture and replacement, is almost sure to be followed by the development of a septic peritonitis and by the death of the patient. Therefore, the performance of a Cesarean section on a patient, who has developed a temperature during labor, or in whom a questionable uterine discharge has developed, should never be considered when any other method of delivery is possible, since, although these symptoms do not necessarily denote an infection of the uterus, they are so strongly suggestive of it as to absolutely contra-indicate an elective abdominal delivery. There are, however, many border-line cases in which uterine infection cannot be definitely demonstrated, in which the question of operation will inevitably arise, and these cases require the most careful judgment. There is no question but that each vaginal examination made shortly before or

during labor predisposes to uterine infection, and, therefore, a patient who has been subjected to repeated vaginal examinations during labor, even under the most favorable conditions must be looked upon as a relatively unfavorable surgical risk, and an abdominal delivery should be avoided, if possible. It naturally follows that the less perfect the aseptic precautions at examination the greater will be the risk of infection with a corresponding increase in the risk of the abdominal delivery.

Experience has also shown that the prognosis of Cesarean section is altered very markedly for the worse if any attempts at operative delivery *per vias naturales* have preceded the section, although the aseptic technique of the operator may have been above reproach. For this reason Cesarean section should never be considered as a legitimate operation after the failure of a serious attempt at delivery *per vaginam*, except in the rare case when the extraction of even a perforated child is considered impossible.

The statistics of the Cesarean operation seem to show furthermore that the toxemia produced by the muscular exertion of labor has a marked influence on both the mortality and morbidity of abdominal delivery, as distinguished from true infection, and it seems certain that the effects of uncomplicated labor must be considered as affording a relative contra-indication to Cesarean section. Primary Cesarean section, i.e., operation at the time of election, before labor begins, or in the early hours of a slight labor, is attended with practically no maternal or fetal mortality or morbidity. Each hour of active labor apparently adds to the risk of operation, although in the first twelve hours of labor the risk to the individual patient will be a comparatively slight one, unless the labor is unusually severe. After labor has become active the risk increases steadily until the point is reached sooner or later at which the risk of abdominal delivery is too great for the operation to be advised, except as

the only possible means of effecting delivery, although many cases will undoubtedly recover if operated on at even a late period of labor and when apparently exhausted. This increase in the risk of operation is so definite that a secondary or late Cesarean operation should never be advised unless the patient and her husband have a clear understanding of the risks involved, and have deliberately chosen to assume the risk for the sake of having a living child. If the rhythm of the uterine contractions is unchanged, if the uterus relaxes normally between contractions, if the membranes are unruptured and no attempts at pelvic extraction have been made, the results of the late operation will be better than if the converse of these conditions exists, but the late Cesarean must be classified as a dangerous surgical procedure and should only be undertaken when no other method of delivery seems possible, unless the patient understands the risks involved and is willing to assume them.

The primary object of an abdominal delivery is in most cases to preserve the life of the child, but the mother should never be subjected to an avoidable dangerous operation in order to save a child, whose life must be regarded as compromised by the strain of a long hard labor, without a full understanding of the risks involved.

Patients who are suffering from the acute exanthemata or other acute infectious diseases should be regarded as infected cases. An abdominal delivery should never be considered in cases of this nature, except when the mother's life is despaired of and the child is alive and in good condition, provided any other method of delivery can be undertaken with a hope of conserving the chances of the mother, even though it may involve the sacrifice of the child, since under these conditions the development of a septic peritonitis is extremely likely.

Acute and chronic nephritis should also be regarded as relative contra-indications to the elective Cesarean section,

as the patient will seldom be in a condition to withstand even a mild peritoneal infection on account of her lowered resistance, and it is probable that a certain degree of peritoneal infection follows almost every laparotomy.

For an abdominal delivery to be justifiable the patient must be in such surroundings that it is possible to provide aseptic conditions for the performance of the operation and proper care for the patient after operation.

THE INDICATIONS FOR THE CESAREAN OPERATION.

In the early days when Cesarean section was seeking recognition as a legitimate surgical procedure it was natural that its advocates should be extremely cautious in recommending its performance, and as we look through the early literature we find that the indications for which the operation was advised were limited to those cases in which the pelvic delivery of a living child was thought to be impossible, whether on account of contraction of the pelvis, the size of the child, or because of obstruction of the pelvic canal by a new growth to a degree that the passage of the child through the pelvis was an impossibility. For this reason we find that the absolute pelvic indication for the Cesarean section was placed at a point at which the delivery of a full term child, even after a destructive operation, was impossible. Contraction of the true conjugate to 5 cm. or below was originally set as the absolute indication for the operation. The relative indication was placed at $7\frac{1}{2}$ cm., it being usually possible to extract a child after a destructive operation through a pelvis the true conjugate of which measures more than 5 cm., although it is impossible to extract an unperforated child (at term) through a pelvis under $7\frac{1}{2}$ cm. The good results which attended the Cesarean operation under proper conditions have led to a marked extension of the pelvic indication. At the present time $7\frac{1}{2}$ cm. has been agreed upon as the absolute indication

for Cesarean section, it being impossible for a spontaneous or an operative pelvic delivery to be accomplished through a pelvis of this size or smaller if the child is of average size. The relative indication has been likewise broadened to $8\frac{1}{2}$ cm. in flat pelves and 9 cm. in generally contracted pelves, since Cesarean section at the time of election has been demonstrated to be less dangerous for both mother and child than an operative pelvic delivery in pelves of this size. It is fair to say, however, that at the present time we do not consider the degree of pelvic contraction as the most important factor to be considered in deciding on a Cesarean section, and we recognize that the size of the fetal head as compared with the pelvic canal is of greater importance in the majority of cases than the size of the pelvis alone. There is no doubt but that if the majority of patients, who present a relative indication for Cesarean section are allowed to go into labor, they can be delivered of a living child after a pubiotomy, in case other methods of delivery fail, and the difference of opinion that exists among different authorities as to the method of conducting cases which are close to the upper limit of the relative indication depends on the personal equation of the individual obstetrician. One operator will say that in his opinion all primiparæ in whom the outcome of labor is only slightly dubious, should be submitted to the test of labor, the final delivery to be accomplished in accordance with the results of this test. Other operators believe, that with Cesarean section at the time of election demonstrated to be a safe operation, all cases in which a real doubt as to the outcome of labor exists should be submitted to a primary Cesarean section as the safest method of procedure for both mother and child. The reason for this difference of opinion seems to be that the operators, who prefer to treat the doubtful cases by the old established methods of obstetrics and see what the outcome of labor will be before deciding on the treatment, be-

lieve that they are pursuing a conservative policy, since a considerable proportion of the doubtful cases will undoubtedly be delivered either spontaneously or by pelvic operation of moderate difficulty, although a considerable number of the babies will be lost, and a greater number of mothers seriously injured by this policy. It seems fair, however, to ask under the present conditions what is conservatism? Is a man a conservative who knowingly subjects both mother and child to a serious risk because in the days before Cesarean section was demonstrated to be a safe operation the pelvic operations were the only ones which could fairly be advised in doubtful cases, be the results what they might; or should a man be classed as a conservative who says frankly, after exhausting every means at his command to arrive at a conclusion, that here is a patient in whose case the outcome of the older methods is doubtful, but that a primary Cesarean section performed before labor begins practically guarantees the life and health of both mother and child at a minimum of risk? It seems to me that in this connection conservatism is a poor word, since to me conservatism means the conservation of the interests of both patients at the least possible risk for either mother or child, whereas in the ordinary acceptance of the term conservatism is taken to mean following the traditions of obstetrics that were established in the days when abdominal surgery was considered almost necessarily fatal.

I believe that all patients in whom a serious doubt exists as to the probability of a spontaneous or easy operative delivery are best treated by primary Cesarean section, and that the test of labor, except in cases where the patient chooses to undergo this test with a full understanding of the dangers which it entails, should be obsolete. We cannot, however, lay down a definite rule which will cover all cases. In cases of doubt the patient should be anesthetized during the last month of pregnancy and the attempt made to en-

gage the fetal head in the pelvic brim. If this is possible and no other reason for abdominal delivery exists the patient should be allowed to go into labor. If, however, it is impossible to engage the head in the brim, and particularly if the head definitely overlaps the symphysis pubis, Cesarean section should be unhesitatingly chosen as the safest means of delivery.

We recognize at the present time that there are certain other factors which must be considered in the given case. If the comparison between the maternal pelvis and the fetal head shows only a slight discrepancy, we know that the majority of women will succeed in molding the fetal head to a degree that it will pass through the pelvic brim, if the uterine contractions are of normal force, but we must consider first whether in the given case this molding is liable to occur, and second whether the maternal powers are sufficient to accomplish this without undue strain. For proper molding of the head to occur two factors are necessary; first, powerful uterine contractions to shape the head, and second, a head which is not unduly ossified. If the patient is well nourished and in good muscular condition it is fair to assume that she will have normal uterine contractions which will exert sufficient force to produce proper molding of the head. If, however, she is feeble and flabby muscularly, it is at least possible that the uterine contractions will be too weak to accomplish the degree of adapting necessary for the passage of the head through the pelvis; and in cases of this sort there is no question but that a primary Cesarean section, though perhaps unnecessary in certain cases, offers less risk for both mother and child than the test of labor and a difficult pelvic operation afterwards. We cannot estimate the ossification of the fetal head until after labor has begun, and this must always remain an uncertain factor in our choice of operation, unless we decide to apply the test of labor in all doubtful cases.

Contraction of the pelvic outlet, combined or not with a faulty inclination of the pelvis, probably causes more trouble in our American-born women than contraction of the pelvic brim, and the pelvic outlet should always be carefully measured during pregnancy. If the transverse diameter of the outlet between the ischial tuberosities measures more than $8\frac{1}{2}$ cm. it is fair to assume that the pelvic outlet will cause no obstruction to the delivery of an average sized child. If, however, the transverse diameter of the pelvic outlet is less than $8\frac{1}{2}$ cm. the passage of the outlet is likely to be attended with considerable difficulty; marked laceration of the soft parts is almost inevitable, and it is also possible that serious injury to the child may occur. In these cases the posterior sagittal diameter of the pelvic outlet should also be measured, i.e., from a line joining the posterior margins of the ischial tuberosities to the tip of the coccyx, and if this diameter measures not more than $8\frac{1}{2}$ cm. a difficult delivery with serious injury to the soft parts is almost inevitable, but if the posterior sagittal diameter is increased to more than $8\frac{1}{2}$ cm. a normal child can probably be delivered through the pelvis without serious damage. Patients who present irregular contractions of the pelvis, due to hip disease or some spinal malformation must be considered individually for no rules can be laid down to cover these cases, and all that can be said is that if, after a careful palpation of the pelvis under ether, definite doubt exists as to the ability of the head to pass the pelvis, a primary abdominal delivery is advisable.

Another definite indication for the performance of Cesarean section is overdevelopment of the child, and this is where many operators of to-day err in their choice of operation. It is not at all uncommon to hear an obstetrician say in defending his choice of treatment in a given case, resulting in the loss of the baby, that the pelvic measurements were normal, and that therefore he did not consider

the possibility of serious trouble, but his position is not a defensible one since it is not the size of the pelvis alone that counts, but the comparison between the size of the head and the size of the pelvis, as it is equally difficult for an over large child to pass through a normal passage as for a normal child to pass through a contracted passage, and the comparison between the child and the pelvis must be carefully made in each individual case before the method of delivery is selected. So much for the pelvic indications, which are usually considered as the real indications for Cesarean section. There are, however, certain other conditions in which an abdominal delivery, though perhaps not definitely indicated, will give better results than the ordinary methods of delivery.

Patients who are in poor physical and nervous condition, who have not reacted well to the strains which have been put upon them in their ordinary life, and who, instead of improving during their pregnancy, come to labor in poor shape, should be regarded as doubtful obstetric risks. In a patient of this sort the physical strain of a prolonged labor, or the nervous effect produced by pain alone, may be sufficient to produce a prolonged period of invalidism following delivery by the ordinary methods. On the other hand, patients of this type will usually undergo an operative delivery better than they will the strain of a prolonged labor, and it is fair to offer such patients the choice of an abdominal delivery, although we may have no real fear as to the outcome of labor as regards the life of either mother or child, simply on the basis that the patient is in no condition to undergo any severe strain when that strain can be avoided by a safe surgical procedure.

Any patient to whom the life of the child is of unusual importance may fairly be advised to have an abdominal delivery at the time of election. Elderly primiparæ who may never have another child occupy the first place in this

group. When no pelvic indications are present we recognize that an abdominal delivery is unnecessary in most instances, but the life of the child is of such great importance in these cases, and the danger of serious laceration of the maternal soft parts is so great, that Cesarean section is, in my opinion, the conservative course, except when careful examination shows a distinctly small child and little or no rigidity, of the maternal soft parts. Primiparæ who have been married for several years without becoming pregnant and women who, having had repeated miscarriages have at last been brought through to term by the use of unusual precautions, may be fairly considered as belonging in this group. There is no question but that Cesarean section offers the safest method of delivery for the child, and it is important in women of this class, who may never have another child, that no avoidable risks for the child should be taken, and unless the mother declines a Cesarean operation abdominal delivery is unquestionably the safest method to employ.

Patients in whom the soft parts are unusually rigid or who present more or less atresia of the vagina, whether as the result of scar tissue from previous deliveries or from operations, will be better off for an abdominal delivery than if they are seriously lacerated as a result of a pelvic delivery, and in the same class may be placed patients who have been seriously lacerated at their previous deliveries and on whom operations for repair have been performed with satisfactory results, since in these cases it is very probable that a serious laceration will attend a pelvic delivery and that the patient will probably have to be subjected to a secondary operation for repair later. It is perhaps not fair to consider this as a definite indication for Cesarean section, but it is always fair to offer the patient the chance of being delivered by a safe method which will not entail the probability of a secondary operation afterwards.

Multiparæ who have lost one or more children in previous labors, particularly if they have been under the charge of supposedly competent practitioners, may properly be considered as offering indications for an abdominal delivery. This is particularly the case when the babies have been lost at operation following prolonged unsatisfactory labors, in which the uterus has acted badly and the contractions have been ineffective and irregular, suggesting the early development of a contraction ring. As a general rule, a uterus which has acted poorly in one or more labors will act badly in subsequent labors and the safest course for both patients in cases of this nature is a primary Cesarean section at the time of election, even though no definite pelvic indication can be made out.

Pelvic operations, particularly operations on the uterus, as for instance an attempted suspension which has resulted in a fixation, not infrequently cause serious trouble in subsequent labors and every patient who has had such an operation should be carefully examined during the latter part of pregnancy. If the cervix is found in its normal position and within easy reach there is little chance that the previous operation will cause any marked dystocia, but if the cervix has been drawn up toward the promontory of the sacrum during the development of the uterus, and is only to be reached with difficulty, if at all, there is every reason to believe that a pelvic delivery will prove either impossible or extremely difficult, and a primary abdominal delivery can be properly undertaken in the interests of both mother and child. In case the uterine operation has been a myomectomy the possibility of uterine rupture during labor must always be considered, and if the extent of the operation is known an intelligent choice can be made, otherwise the obstetrician must consider the probabilities and act accordingly.

Tumors which obstruct the pelvis may also furnish an

indication for abdominal delivery, and the probable necessity for operation should be known before the onset of labor. Cancer of the cervix always causes bleeding during pregnancy, and the cause of bleeding during the latter part of pregnancy should always be carefully investigated, and the diagnosis made. If the cancer definitely obstructs the vagina an abdominal delivery is indicated in the interests of both patients. If the cancer is in the early stages and a radical operation is possible, an abdominal delivery should be performed as soon as the diagnosis is made, followed by a complete hysterectomy, irrespective of the period of pregnancy. If the cancer is inoperable the choice of treatment is open to doubt. If a portion only of the cervix is involved and it is considered that the remainder will dilate properly so that a child can be delivered through the pelvis without subjecting the mother to undue risk from hemorrhage or sloughing a pelvic delivery is allowable, but it must be remembered that in these cases the child is the important patient, since the mother's condition is hopeless, and that if any doubt as to the possibility of a safe delivery through the pelvis exists, an abdominal delivery is indicated for the sake of the child, and to a certain degree for the sake of the mother, on account of the danger of serious bleeding, or of absorption following the sloughing of the cancerous tissue, events which are almost sure to follow the dragging of a child through the diseased cervix, thus tending to shorten the mother's life.

An ovarian tumor blocking the pelvis at the time of labor is a definite indication for an abdominal delivery, but an ovarian tumor of any size should have been discovered and removed during the pregnancy, but, if it is not discovered until after the patient is in labor, it should, if possible, be raised out of the pelvis by taxis and the patient allowed to deliver herself. If, however, it is impossible to raise the tumor an abdominal section should be performed and the tumor removed. Operators differ as to the advisability of

performing a Cesarean section at this time or allowing a patient to go on in labor and deliver herself, but my own preference is for the performance of Cesarean section, since I believe that the continuance of labor is inadvisable under these conditions.

Fibroid tumors of the uterus may or may not furnish indications for an abdominal delivery. A single fibroid tumor situated in the upper portion of the uterus will seldom cause trouble during labor unless by rendering the uterine contractions irregular and feeble. Multiple fibroid tumors of the fundus of the uterus, if of any size, are almost sure to make labor unsatisfactory, and the safest method of delivery will not infrequently be a Cesarean section followed by an hysterectomy. Fibroids of the lower uterine segment not infrequently block the pelvis and render delivery by the ordinary methods impossible. It must not be forgotten, however, that fibroid tumors usually undergo more or less softening during labor, and sometimes a tumor which seems to offer an insuperable obstacle to delivery will be drawn up out of the pelvis under the influence of the uterine contractions. For this to happen, however, a strong active labor is necessary. It seems fair in these cases to allow the patient to go into labor for a few hours, observing her carefully to ascertain what effect the labor is having on the fibroid. If labor is unsatisfactory an abdominal delivery followed by an hysterectomy or a myomectomy should be performed. Any other tumor, whatever its nature or origin, which so blocks the pelvis as to interfere with the passage of the child, furnishes definite indications for abdominal delivery.

Patients with valvular heart disease, particularly mitral stenosis, not infrequently will be more safely delivered by Cesarean section than if allowed to go into labor. This is particularly true of primiparæ, whose soft parts are rigid, since the strain of labor on the seriously diseased heart is apt to be followed by a severe and perhaps fatal collapse,

and in a patient in whom labor promises to be fairly difficult this risk should not be run since Cesarean section offers a much safer method of delivery. In multiparæ, in whom the soft parts are relaxed and easily dilatable, abdominal delivery will very seldom be necessary and need not be considered, but in primiparæ it should receive careful consideration. Much depends on the way the heart has acted during pregnancy, although my own personal belief is that a labor of even moderate severity, although it may not kill the patient, may leave her a semi-invalid for the rest of her life, and that her interests are often best conserved by an abdominal delivery.

A complete placenta previa close to term with mother and child in good condition will occasionally furnish an indication for an abdominal delivery. If the cervix is long, rigid and not taken up, a condition sometimes seen in primiparæ, or if there is a marked pelvic contraction, abdominal delivery is indicated. If, however, the cervix is soft and easily dilatable, or if the child is markedly premature, pelvic delivery is the best method, particularly if the patient has lost much blood.

Eclampsia is often cited as an indication for an abdominal Cesarean section, but to my mind, except in the presence of a pelvic indication or excessive edema of the vulva, an abdominal delivery is unwise. The results of abdominal Cesarean section for eclampsia have given approximately a 50 per cent mortality, which is too high to render the operation advisable, since the mortality by other means of delivery varies from 10 to 25 per cent.

Patients who have had one Cesarean section are most safely delivered by Cesarean section in subsequent pregnancies, for although the indication for operation may have been removed at the first operation this is not usually the case, and the uterine scar occasionally ruptures if subjected to the strain of labor.

Hysterectomy following Cesarean Section. The removal of the uterus following Cesarean section becomes advisable under certain conditions and adds considerably to the risk of operation. It is, therefore, not an operation to be lightly undertaken, and, if possible, without adding to the risk of the patient, the hysterectomy should be deferred to a subsequent time. In certain conditions, however, it is a necessary operation. If Cesarean section becomes necessary on a patient with a uterus already infected, — because delivery by other means is impossible, — the uterus should always be removed, because the suturing of a septic uterus and its replacement in the abdominal cavity is almost sure to result in a septic peritonitis and death. Under these conditions the mortality of operation will be high, but it will be much lower than if the uterus is closed and replaced in the abdomen. In rare cases uncontrollable hemorrhage following Cesarean section may necessitate an hysterectomy, but in most cases it will be possible to control the hemorrhage by other means, such as compression or even ligation of the uterine arteries, and the removal of the uterus will not be necessary. Multiple fibroid tumors of the uterus may necessitate an hysterectomy, although this will seldom be necessary. In most cases the patient's interests will be best conserved if the uterus is sutured and restored to the abdominal cavity, to be removed at a subsequent date after the involution of both the uterus and tumors have taken place, and the risks of operation are materially less than if the operation is performed at the time of the Cesarean section.

PUBIOTOMY.

The status of pubiotomy in obstetrics is as yet undetermined. Comparatively few operators will be found who, at the present time, prefer to perform a pubiotomy as a primary operation on an uninfected case in preference to a Cesarean section. Some operators go so far as to decline a pubiotomy

in any case preferring even a craniotomy on a living child to the risks attendant on pubiotomy. Pubiotomy, although a great improvement over the older operation of symphysiotomy is not an operation without risk, and at least one patient has died of hemorrhage at operation, while a considerable number have been more or less seriously invalided. Serious infection of the pelvis originating in the pubiotomy wound has occurred in some cases. Extensive injury of the bladder and non-union of the pelvic girdle have also been seen. On the other hand, in the hands of its advocates the results of pubiotomy seem to be satisfactory at the present time. It is certainly a safer operation from the standpoint of the maternal life than a Cesarean section when the conditions laid down in the early part of this paper cannot be fulfilled, particularly when a suspicion of sepsis is present or the patient has been in labor for a long time. Its field of usefulness is, however, a somewhat narrow one, for it cannot be properly undertaken when the true conjugate diameter is less than $7\frac{1}{2}$ cm. and the child is of average size, because the spreading of the pelvis to a degree sufficient to allow the fetal head to pass in markedly contracted pelvis may result in permanent disability of the patient, owing to injury to the sacro-iliac joints. It is certainly, therefore, not a substitute for Cesarean section when the absolute indication is present.

I believe that it has a legitimate place in obstetrics, and I should define the indications for its performance as follows: When a patient has been in labor for some time with a pelvic contraction of not less than $7\frac{1}{2}$ cm. and the child is alive and vigorous, pubiotomy is unquestionably the safest operation at our command for both mother and child, although rather more dangerous to the mother alone than a craniotomy. The risk to the maternal life is less than if a Cesarean has been performed under similar conditions, and the child is given a chance for its life, the only alternative

operations being Cesarean section on the one hand and craniotomy on the living child on the other. Certain operators prefer Cesarean section followed by removal of the uterus feeling that pubiotomy has no place in obstetrics, but I believe that under the conditions defined pubiotomy is a legitimate operation, and in the majority of cases the end results will be satisfactory, although as a primary operation at the time of election it is my belief that as compared with it Cesarean section has every advantage and no disadvantages.

DISCUSSION OF ARTICLE XIV.

DR. F. H. CARY, Worcester: I have been very much interested in Dr. Newell's most able paper on "The Indications for the Performance of Major Obstetrical Operations." The ground has been so thoroughly covered that I have not much to add. There are many questionable cases in which it is difficult to decide whether they call for interference by Cesarean section or be allowed to make a fair trial by the natural channels. A case in point entered the Hospital not long ago — a woman in the late twenties who had had one previous pregnancy which ended in a miscarriage at the third or fourth month. She entered the Hospital at the eighth month, and the question of interference by Cesarean at term was carefully considered: the pelvic inlet so far as measurements were concerned was normal. In childhood she had been operated on for a tubercular hip and several times since for discharging sinus. The left thigh was ankylosed and in a position of about two inches of adduction. An x-ray was taken, and was fairly satisfactory as it showed no flattening of the pelvic inlet on that side, and there seemed to be a fair amount of room and a not over-large baby. The question arose of some possible difficulty at the pelvic outlet due to the ankylosed condition of the thigh and the degree of adduction. If the case made a favorable start with membranes unruptured until dilatation was nearly completed, it seemed as though the head would descend through the brim and be born through the normal birth canal or come within

fairly reasonable reach for low forceps. This would probably have been the case had the membranes remained unruptured and the patient had strong regular pains; but unfortunately the patient was awakened in the night by the sudden rupturing of the membranes, leaving a dry uterus. Shortly afterwards labor began and progressed slowly until full dilation with the head resting above the promontory and not well engaged; here progress ceased and the head would not enter the brim nor could it be made to do so by manipulation. At this point the only choice lay between high forceps and version. Forceps were not attempted; version was performed and we just missed success, the baby just having passed possibility of resuscitation. After the patient was prepared for operation I was very much struck with the difficulty of entering the pelvis with the thigh in this position of ankylosis and the pelvis apparently somewhat tilted, throwing the promontory forward so that one had to go through sort of a letter S curve. The difficulty came in getting down the right arm. This difficulty seemed to be much more impressive in what might be called a post partum consideration rather than in an ante partum, and in this respect it would seem as though some of these cases present a more positive indication for Cesarean.

Regarding interference by Cesarean section after suspension or fixation of the uterus, we have had a number of cases at the hospital all of which have been delivered by the vaginal route without any great difficulty. These women were examined early and where the os was posterior, by traction with the finger anteriorly the anterior section of the lower uterine segment has been shortened, and in other cases we have used the hydrostatic bags thus thinning out the uterine wall and allowing the descent of the head into the brim.

Regarding Cesarean section in eclampsia, we feel at Worcester that we have obtained a fairly low mortality with the use of *veratrum viride*, giving this in the form of *veratrone* subcutaneously and pushing it until the patient's pulse is lowered to seventy or even into the sixties or fifties, thus lowering the blood pressure; nearly all the cases delivering themselves without recurrence of convulsions, a procedure

which seems to be preferable to major interference, and this line of treatment has not affected the fetal mortality. We feel that in many communities veratrum is not used in these cases to the extent that it should be to control convulsions and to allow the patients to deliver themselves.

DR. J. C. HUBBARD, Boston: I am particularly pleased to see an Obstetrical paper on the list of subjects in the Surgical Section meeting. Obstetrics is finally taking its proper place.

One more change along the same line should be made, namely, those practitioners connected with the hospitals devoted to obstetrics should be designated as surgeons, rather than physicians.

I am sorry that Dr. Newell said nothing about the indications during the progress of a case for applying high forceps or for doing a version. It seems to me that the determination of the proper moment when to interfere is a very difficult matter.

High forceps and version may not be classed, perhaps, as major operations as is Cesarean section, but there is no question whatsoever, that there are fewer men who can do a good high forceps, than there are men who can do a Cesarean section. Personally I should have been glad to have heard from him about how he decides when to interfere. While I always make a point of measuring all primiparæ who come to me, I feel that the conclusions based on measurements at the best are rather uncertain. As the question of a difficult labor depends on the relative size of the baby and the mother, measurements of the mother alone are, of course, of less value. When it comes to determining the size of the baby in utero, one is dealing with a very hard problem, it seems to me.

I wish to lay emphasis on the obliquity of the pelvis as an indication for a Cesarean section. I think that is a very important subject, and probably it is not as well recognized as the small pelvis. If the pelvis is so tilted on the spine that the uterus cannot force the baby out through the natural passages, even though they are sufficiently large, a Cesarean is then indicated.

I wish also to lay stress on the importance of doing Cesarean sections in cases of heart disease. There is absolutely no question whatsoever but that a Cesarean section is the proper method of delivering a woman who has a heart which is sufficiently diseased to cause symptoms. I might even make it stronger than that, and say that Cesarean section is the proper method of delivery of a woman who is known to have an organic heart lesion, though it may have as yet caused no symptoms. A Cesarean puts practically no strain whatsoever on the heart, whereas labor necessarily puts much strain on that organ.

In the main I agree entirely with what Dr. Newell has said, and feel that in doubt it is much safer to do a Cesarean than to lose a baby. My custom is, with the first baby, where there is any question in my own mind about the possibility of getting it through, to frankly talk the situation over with the family, and explain to them that the measurements of the mother and the baby furnish a rather indefinite guide. If the parents wish to gambol with the life of the first baby in order to determine the possibility of having children by the natural passages well and good. If they wish to take no chances, then have a Cesarean section. Where I feel that I cannot pull a baby through with high forceps then of course I express my own definite preference for a Cesarean. If I think I can pull it through even with tears, then it seems to me to be fair to the parents, if young, to let them determine the manner of delivery.

I disagree with Dr. Newell in considering chronic nephritis a contraindication to Cesarean section. I have never personally had to face this complication, but should have the same feeling here as in any surgical case, that if an operation is a necessity, the nephritis is no contraindication. In the same way if a Cesarean is indicated definitely, I should carry it out in the presence of a nephritis.

ARTICLE XV.

THE OPERATIVE AND POST OPERATIVE
TREATMENT OF ACUTE INFECTIOUS JOINTS.

BY EDWARD H. NICHOLS, M. D.
OF BOSTON.

DELIVERED JUNE 11, 1912.

THE OPERATIVE AND POST OPERATIVE TREATMENT OF ACUTE INFECTIOUS JOINTS.

I SHALL include in what I have to say about infectious joints, first, those joints the lesions of which are known to be due to the ordinary pyogenic bacteria, second, those joints known to be due to other bacteria, such as the gonococcus; and finally those joints, unfortunately not rare, which on account of their clinical history of sudden onset, violent pain, tenderness, swelling, chill and temperature and limited motion are assumed to be due to bacterial infection, although at operation no causative bacteria are found. This last class does not include the general diseases of the joints that have been described under the term of "rheumatoid arthritis" and a great variety of similar terms. The clinical history and manifestations of this third class of joints, and the amount of destruction and functional impairment produced, vary a great deal and will be discussed in detail under the proper heading. I shall try to illustrate the points I wish to make by giving typical clinical cases.

The first class of cases, the purulent joints, due to ordinary pyogenic bacteria, are much more common in hospital practice than in private practice. Some are due to direct trauma, for instance, a fall on a nail, or a kick by a horse. Others may be due, unfortunately, to the infection of operative wounds of the joints. The traumatic cases may be associated with an immediate escape of synovial fluid from the wound, especially in the case of the knee joint; in other cases the penetration of the joint may not at first be apparent, and it is only after two or three days when the joint begins to

show evidence of inflammation that infection of the joint is suspected, *i.e.*; when pain, swelling, tenderness and septic temperature occur. The end-results of many of these traumatic cases are disastrous, a fact known to all surgeons, but many of these disastrous results can be avoided, provided proper surgical treatment is carried out at once, if only it is realized that any punctured or open wound near a joint may lead to penetration and infection of it. In any suspected case, the patient should be etherized at once, the wound should be carefully cleansed of all foreign material and rendered as aseptic as possible, just as would be done in the case of a compound fracture, and after that there should be an open examination of the joint to see if the synovial membrane has been punctured. If the synovial membrane has, or probably has been punctured, the joint itself should then be opened wide, irrigated with large amounts of hot sterile salt solution, or with 1:10,000 corrosive solution and then closed tight with a dressing of elastic compression; and in the case of knee joints by extension. Murphy of Chicago has recommended, in infected joints of similar type, an injection of a weak solution of formalin into the joint, as the formalin is supposed to be able to destroy any infectious bacteria present. I have had no experience with the method, but it certainly sounds plausible and worth trying. The statement of the simple procedure just given may lead to undesirable interference. Such a procedure imperfectly carried out is worse than expectancy; it should be done only by those adequately trained and sure of their asepsis.

Other cases of the purulent type frequently are secondary to suppurative inflammation of bone adjacent to the joint, *i.e.*, they are secondary to infectious osteomyelitis. In most cases of osteomyelitis of the shaft of the long bones, there is some effusion into the adjacent joints, but fortunately in most cases the effusion is due merely to an overflow of the inflammatory exudate into the area of least resistance, that

is, into the joint cavity. It is impossible often, however, in these cases, to be sure from the clinical history whether the effusion is infectious or not, because the pain oftentimes is referred to the vicinity of a joint, so that it should be a routine practice, in those cases, to aspirate the joint, and to take a culture of the fluid with the greatest aseptic precautions, before opening the bone focus. If the joint contains cloudy serum or seropus, in some instances the mere aspiration may suffice to put an end to joint symptoms, provided the bone focus is immediately opened and adequately drained. If the effusion is markedly purulent, the joint should be opened and irrigated with very hot salt solution before opening the bone focus, perhaps with an injection of the formalin solution, and immediately closed, and in many cases it will be possible to avoid further destruction of the joint. In some cases where the joint exudate is markedly purulent, this method will not avail to limit the infection and destruction of the joint, and, in such cases, permanent drainage may have to be carried out.

Occasionally suppuration of the joint appears spontaneously, with no recognizable bone lesion. These cases, fortunately, are not common. They begin, as a rule, with a very acute onset, with pain, chill, fever, swelling, violent pain on motion in the extreme cases, and when aspirated show a joint filled with sero-pus or true pus. The treatment in these cases is always difficult to select. Surgeons often resort to opening of such joints, with permanent drainage such as they would provide for any abscess cavity, and a vast majority of these cases result in complete disorganization of the joint, excision, amputation or death. In many cases other methods should be tried.

Aspiration alone may succeed in a limited number of cases. The following case illustrates the possibility. F. G., a man 50 years old, a marble setter, was admitted to the Boston City Hospital, January 8, 1910. Ten weeks previously

he began to have pain and swelling of the right knee. He was treated in the Out Patient Department for a week, improved and went to work, when the knee began to swell again. He had fever, sweats and chills. There was no involvement of any other joint. The knee was swollen, very painful on motion and tender, with not more than 45 degrees of motion. Temperature on entrance 100 degrees. Three days later on account of rising temperature and pain the knee was aspirated with a small trocar, allowing an escape of a large amount of seropus, and a culture from this fluid showed streptococcus and staphylococcus. A plaster of Paris bandage was applied, fixing the knee joint. The temperature came down to normal on the third day, and pain disappeared. After a week the plaster was split, and passive motion was begun. The patient was discharged at the end of two weeks, still wearing a plaster. In what class of cases such aspiration promises to succeed I cannot state with certainty. It should be tried, I think, in many of the more moderate of the severe cases. A very profitable method might be to combine with aspiration the injection of formalin, with extension to separate the articular surfaces.

In a majority of cases immediate incision and extensive irrigation of these joints with salt solution, as hot as can be borne on the hand, is the best treatment, followed by immediate closure of the wound. I have found the best method of suture to be interrupted silkworm-gut sutures, introduced through the skin and capsule down to the synovial membrane on one side, crossing over to the capsule and coming out through the skin on the opposite side. Those sutures are put in loose and are not tied at first. Then the skin incision is closed by a buried subcuticular silkworm-gut stitch, and the loose interrupted sutures are tied over this subcuticular suture. This method of suture is applicable to all wounds of joints. It gives absolute approximation and the quickest possible skin healing and no foreign body

is introduced into the joint itself. In large joints, like the knee joint, fixation should be obtained by traction and a loosely applied ham splint, rather than by plaster. A fair percentage of these cases quiet down under this method of treatment, provided the effusion is seropus or thin pus.

The following case illustrates this method: E. C., a girl 18 years old, with no history or evidence of gonorrhea, was admitted to the Boston City Hospital. About two weeks previous there had been stiffness and swelling of her right knee, the next night she had severe pain, with chill and fever. The knee swelled enormously, and the patient could not walk. There was pain on pressure, great tenderness on motion, which was limited to a very few degrees. She was operated on about ten days after her admission to the wards. An incision was made three inches long on the inner side of the patella, parallel to the patellar ligament. The joint was opened, with the escape of several ounces of bloody seropus and fibrin. The joint was irrigated thoroughly with very hot salt solution, as hot as could be borne on the hand, and the wound was closed in the manner already described. The patient was put to bed on a Bradford frame, with ten pounds of extension to the leg. Four days later the temperature was normal, and there was no pain in the knee. The stitches were out on the twelfth day. Four days later a few drops of pus appeared in the skin incision, the infection never, apparently, being connected with the knee joint. Five days later the temperature became normal and remained so. Three weeks after the operation there was slight swelling and tenderness of the knee, and passive motion was started. The pain of the passive motion was great. Three weeks later the patient was on crutches, the motion of the joint was increased a good deal, and there was no fluid in the knee joint. The patient was discharged with directions to carry on passive motion, voluntary motion and massage in the Out Patient Department. Seen

two years later, the patient had about 45 degrees of motion.

In those cases where the contents of the joint cavity is thick pus, a true "abscess of the joint," the method just described probably will fail, and, in such cases, the surgeon is met by the question of permanent or temporary drainage of the joint. My own experience with such joints has been chiefly with the knee joint, and what I have to say about drainage will apply chiefly to that joint, although deductions as to other joints also can be made. It is to be borne in mind that the synovial membrane of the joint cavities, as a rule, has very limited power of protection against bacterial infection; that if drainage of a joint is continued for any length of time secondary bacterial infection surely will take place; that the end result of all such purulent infectious joints tends to produce an abundant formation of granulation tissue on the surface of the synovial membrane and over the joint cartilage, with partial or complete obliteration of the synovial cavity, and ultimately a fibrous or bony ankylosis.

In the first place, it is possible occasionally in the exceptional case to drain a synovial cavity just as one would drain an abscess cavity, without complete destruction of the joint. A. T., five years old, a patient of Dr. C. S. Adams of Wollaston, was seen at the Quincy City Hospital in 1909. Ten days previously the child had fallen down stairs, with no symptoms for a week following. Then there was a chill, high temperature and slight delirium for two days, with severe pain in the left groin. The left leg was everted, there was pain on pressure over the groin, no induration, temperature 98.8 degrees. There was extreme pain on motion, moderate spasm of the adductor muscles. An incision was made on the inner side of the thigh, down to the pectineus muscle and the deep fascia was divided. The finger was introduced between the pectineus and the ileo-psoas muscle, and entered the hip joint with an immediate

discharge of about half an ounce of thin pus. An incision was then made over the trochanter on the outer side of the leg, and a trephine hole was made into the femur. The marrow of the femur was infarcted and beneath the periosteum was thick pus, connecting with a cavity about the hip joint, in which were several ounces of pus. The opening was drained thoroughly, and both wounds packed with gauze. At the same time it was noticed that the right elbow was markedly swollen and from that joint there was drawn by a trocar about an ounce of seropus. Culture from both joints showed staphylococci. The patient made an uninterrupted recovery, and the sinus in the bone ultimately healed. The elbow joint gave no further trouble. The boy has now been well for three years, except for a partial ankylosis of the hip joint, the amount of mobility in which is constantly increasing.

Another interesting case illustrating a very unusual result of open drainage, in this case, of the knee joint, is the following: E. N., a boy, 16 years old. Entered the Boston City Hospital, February 6, 1912. Three days previously after walking a short distance he felt a sudden sharp pain in the left knee and was unable to walk up stairs. There was no antecedent injury. The knee swelled, the temperature was 102 degrees. Tenderness about the knee joint was marked, particularly about the patella, which floated. X-ray examination showed nothing beyond effusion in the knee joint. Nine days after admission, on account of rising temperature, increasing pain and swelling, an incision was made on the outer side of the patella into the knee joint with the escape of several ounces of pus. A counter incision was made on the outer side of the knee and a rubber drainage tube was passed from one incision to the other, beneath the patella, and the wound was irrigated daily with hot boric acid. A month later both sinuses were closed. On May third the patient was discharged with two super-

ficial wounds, which had no obvious connection with the joint. This case is in my experience unique, both in the rapidity and extent of the recovery after permanent drainage of a large joint.

I think it is certain that the failures in these operations of permanent drainage of the large joints will be vastly more numerous, and even in the successes very great limitation of motion will be left.

In some cases drainage through small incisions fails, and rarely such joints can be saved by wide openings. A case operated on my service by Dr. Fred Cotton last September illustrates a result of such a procedure. F. M. H. was admitted to the Boston City Hospital, September 8, 1911. His knee had been injured by a street car fender, which produced a lacerated and punctured wound, with much serous fluid exudate. Three days later Dr. Cotton opened the joint, a parallel incision was made on either side of the patellar ligament. The joint was washed out with 1-5000 corrosive, and four cigarette drains were inserted. Twelve days later on account of the disorganization of the joint, the patellar tendon was divided and the patella was reflected backwards. Five days later the patella was brought down into place. During this time the patient was very delirious. October twenty-eighth many of the granulations were cut away and the patella was cleaned up, and the ends sewed together by kangaroo suture. The wounds still discharged, but at the end of five days the patient was up in a chair, and was ultimately discharged with crutches and plaster. His present functional condition I do not know.

On the other hand, complete opening of such a joint more commonly leads to complete destruction of the joint. For example, C. G., 45 years old, was in the Boston City Hospital in 1898 with a T fracture in the knee joint. On Feb. 11, 1907, he was again admitted, as the night before he twisted his knee, and was unable to use it. Leukocyte count 18,000.

His temperature was about 102 degrees, the knee was swollen, tender and painful. His general condition grew worse, and on February 20th an incision was made into the knee, showing much thick pus, and the knee joint was at the time immediately opened wide by an incision through the patellar tendon. Trephine holes into the femur showed pus in the femur. Septic temperature appeared. The man's general condition failed and finally the leg was amputated. The patient failed to rally and ultimately died. Such is more commonly the history of such cases.

The general history after drainage of these acutely suppurating joints is an apparent relief for a few days, then gradually increasing septic temperature, and great septic absorption. This is due in some cases, particularly in the knee joint, to the fact that lateral incisions do not really drain the joint, so that a large pocket of pus is left below the level of the drainage wound. For this reason some men favor, in the knee joint, drainage of the joint through the popliteal space. In theory this method of procedure is good, but practically it is not always effective. This is due to the fact that granulation tissue from the synovial membrane may separate the knee joint into an upper and lower pocket, and may act as a diaphragm to separate these two pockets. In a case operated on within a week, an extensive abscess of the knee joint, the most extensive I have ever seen, secondary to osteomyelitis of the tibia, the joint was opened by lateral incisions, one on either side of the patellar ligament, and a third incision through the popliteal space into the knee joint. In that case it was easy to demonstrate that the effusion of the joint was in two poorly communicating cavities. If the drainage had been by a posterior incision alone, practically no drainage of the front of the joint would have taken place. In some severe cases, however, I think that drainage of the knee through the popliteal space is indicated, although in the most severe cases, such

as those two already described, drainage of the knee joint by dividing the patellar tendon and laying the joint wide open offers the most hope of recovery. Unfortunately, many of those severe cases come to excision or amputation and many of them die.

Of the joints which appear as a result of infection by other organisms than the regular pyogenic coccus, gonorrheal joints are the most important. As regards treatment by vaccines, my own experience is too limited for me to speak with any confidence. In drawing conclusions as to the value of vaccines, it must be borne in mind that a majority of the cases get well in time, that the disease is a self-limited one, and it often is difficult to say how far the vaccine helps. The cases, as seen in large hospitals, are mostly inveterate cases or cases in which the symptoms are so violent and so acute something has to be done to relieve the patient immediately. In these cases I have found that incision, irrigation with hot salt solution and immediate suture, followed by traction and fixation gives excellent results. For instance, M. M., 23 years old, laborer, had gonorrhea two weeks previous to his entrance to the Boston City Hospital, September 17, 1911. Three or four days later the right knee began to swell, and become red and painful on motion. In spite of fixation his symptoms became worse. On September twenty-ninth the knee joint was opened by a longitudinal incision on the inner side of the patella. The knee joint was washed out with five quarts of hot salt solution. There was seropus in the joint. The wound was closed in the manner already described, and the leg was put on a ham splint with 15 pounds of extension. The wound healed by first intention. Pain disappeared practically at once. December twentieth the patient was discharged on crutches, with about 15 degrees of voluntary motion, and 25 degrees of passive motion. The pain of this passive motion was not as great as it is in many of those similar cases.

Besides the purulent and gonorrheal joints already described, similar infections of the joints, particularly of the knee joint, are not uncommon. In many of these cases neither gonococcus nor any other infectious bacteria are present at any time during the disease. The cases, as a rule, are milder than those already described, but they still begin with acute onset, pain oftentimes extreme, tenderness, swelling and occasional redness. The joints are hot to the touch. It is well known that inflamed joints, due to infection by gonococcus, may at no time show gonococcus present. The same thing is undoubtedly true of infected joints due to other pyogenic infections. Such a case is illustrated as follows. A. N., 39 years old, housewife, married, was admitted to the Boston City Hospital in 1908. She had had four children previously. Five days after the birth of her last child (5 weeks before admission to hospital) she was taken with sudden sharp pain in the left knee, which gradually became swollen, tender and remained so. Pain on motion was extreme, no fluctuation was made out. She was operated on November thirteenth, 1908. An incision was made over the inner side of the patella, into the joint, which was irrigated, and at once closed, and put up on a ham splint with traction. Four days later the patient was practically free from pain. Passive motion was begun two weeks later. She was discharged two weeks after with 25 degrees of motion in the knee joint. Her later history is unknown. These cases could be multiplied.

So far I have spoken only of the operative treatment in the acute stage. Many of these cases here presented were hospital patients who were lost to sight, as far as I was concerned, after their discharge from the hospital. In many of the cases, however, who after operation seem hopeless, so far as function is concerned, because of the great limitation of motion, admirable results are obtained, if the treatment can be followed up over a long period of time. The treat-

ment consists in baking, massage, passive motion, voluntary motion and gymnastics. Voluntary motion by the patient is one of the most essential features. At first pain on motion in nearly all cases is extreme and it requires the courageous and enthusiastic coöperation of the patient in order to obtain good function. Many of these patients are worn out and broken down by the intense suffering they have endured before they come to operation, and it is very difficult to get them to assist in the earlier stages. After the motion of the joint is increased so that they get good muscular leverage, progress is much more rapid, and, as a rule, much less painful. It should not be assumed that in all of these cases good final results are obtained, but most of them may turn out well even in cases that at first seem hopeless. For instance, J. E., 35 years old, captain of an English liner was admitted to the Boston City Hospital in July, 1910. Three months previously while at sea, twenty-four hours run from Buenos Ayres, he was attacked with sudden violent pain in his left knee. The pain was so severe, and the man so ill that the ship was laid to for twenty-four hours until the weather cleared and the mate could be trusted to take the ship into port. The patient was in the hospital for three weeks at Buenos Ayres, all the time with severe pain. He then returned to his ship. His knee was hot, tender, painful and had almost no motion. Although still crippled so that he had to be carried to the bridge, he took his ship to Boston, where I saw him. At that time his knee was much swollen, there was not more than 20 degrees of motion, there was no effusion, the leg was flexed at an angle of 30 degrees, with slight subluxation of the knee, and pain on motion was very great. On July twenty-eighth, under ether, the leg was straightened, the subluxation was corrected, and the leg was put up in plaster. At the end of two weeks, the plaster was removed and passive motion and massage were begun. There was comparatively little pain. The captain was a

most courageous and intelligent patient. He endured the pain of the early manipulations with great fortitude. By September twenty-fourth the swelling had largely disappeared. There was flexion of 60 degrees, he could walk without crutches, and then took command of his ship and returned to England. There he was put in the hands of a very skillful surgeon, who carried out the treatment already begun. The patient writes in December, 1911: "The knee does not trouble me at all, being now able to kneel back and almost sit on it; a feat that I never expected to perform. There is still some weakness in that I cannot run fast, and when climbing a ladder, there is still some lack in strength. The thickening about the knee is gradually disappearing, so that in time I hope to have it perfect, if not, nearly so. I have just had to survey a four masted sailing ship, which involved climbing aloft to inspect the masting and gear. Not bad for a cripple, and no bad after effects."

In conclusion: In suppurating joints it should be remembered that many cases in the early stages can be helped by aspiration and traction, or by aspiration and injection of formalin and traction; but if those joints are to be drained, they cannot be drained too freely, and this is especially true of the knee joint. Some joints which would be lost by inadequate drainage can be saved by a complete opening. In all cases where drainage must be attempted, even if the drainage is most complete, bad function will result in most cases.

Of the infected joints which are not truly suppurating, convalescence is shortened and function is increased in many cases by opening the joint, by irrigation and by immediate closure. In many of these latter cases, marked limitation of function is to be expected, but the function will be surprisingly good, often, if immediate, careful treatment by massage and forced motion is carried out.

DISCUSSION OF ARTICLE XV

DR. H. G. STETSON, Greenfield: It has been my good fortune not to have seen very many infected joints. I have had two infected elbow joints; one, a very bad one, produced by a fall from a box car, that produced a T fracture of the lower end of the humerus extending into the elbow joint. The wound was a compound one and was thoroughly filled with dirt and coal from the railroad yard in which the accident occurred so that it was impossible to thoroughly clean the wound. The man had a very long, dangerous illness but finally recovered with an ankylosed elbow and almost no use of his lower arm.

The other infected elbow was due to a punctured wound extending into the joint, the patient recovering quickly. There was no attempt at drainage of the joint, simply fixation and dry dressings. The joint was closed in three weeks and in from two and one-half to three months, he had a fairly useful joint, with all indications of its ultimately being as useful as the opposite one.

I have seen three infected knee joints. In the first of these a young man injured his knee by falling from a train and striking against a switch rod, producing a small punctured wound, extending into the knee joint. This boy was desperately ill for two or three months, being cared for on another service in the hospital. He had a large amount of pus in his knee, cellulitis of the muscles of the thigh, with multiple pus pockets; free drainage was made everywhere and he finally got well with, of course, complete ankylosis of the knee.

The second case was a woodchopper who came into the hospital with an incised wound of the knee, produced by an axe. I saw this man once or twice in consultation. In appearance, he was seriously ill; there was a small wound extending into the knee joint, from which a thin, foul discharge escaped. The wound was irrigated thoroughly but was not opened up. The man died within a few days of the time I saw him, evidently from a severe septicemia.

The third case, a railroad brakeman, was injured by a fall from a car and by being dragged or pushed along the ground, thus producing a very severe brush-burn on the outer side

of the knee, not involving the knee joint at the time of his injury. Despite all efforts the joint became infected about a week after the accident. This joint was aspirated without any relief and later was freely opened and drained, the whole front of the knee joint being turned up. No relief, and finally, as a life saving measure, the leg was amputated through the middle of the thigh. The patient recovered.

I have had one infected wound of the wrist joint as a result of a severe burn by steam. This man at the end of a year has almost complete use of the wrist joint, now possessing probably 86 per cent of complete functional return. Nothing was done with this beyond rest and an attempt to keep the wound surface clean.

DR. F. J. COTTON, Boston: I think this subject is a very important one; and particularly important, as Dr. Nichols has said or hinted, in that the treatment has left a good deal to be desired in the past. We have but just begun to do adequate work on these cases.

In the City Hospital we see three classes commonly enough:

(a) Gonococcal joints with much or stubborn effusion we open, wash out and immediately close the capsule without drainage. This has worked well.

(b) In other post-infectious cases, including many of so-called rheumatism, in which the culture at the time of operation is sterile, opening and washing out the joint with salt solution with removal of fibrin gives excellent results also; and in these cases also, it is well to emphasize that you ought to close up absolutely — not drain. We have all drained in the past but without very good results, although without any large percentage of trouble.

(c) We have had quite a number of real septic joints in the last few years. With few exceptions they have done not very well. Every one knows how admirably one can get septic infiltration outside from draining the joint. You can get an immense amount of infection in this way. The mortality in cases so treated would be found to be enormous if we could get at the facts.

The first case I wish to speak of in illustration was a case

of streptococcus infection of the knee in a rather feeble woman of 50, without trauma. The infection was apparently without a definite primary focus. She had much effusion, slight fever and malaise. Tapping showed streptococci, but repeated tapping did not at once cure the condition, and I felt I ought to drain.

I drained and the patient died, after the occurrence of enormous infiltrations and abscesses of thigh and leg. Drainage spread the infection all over the lot; she died of septicemia. It seems to me now that I ought to have had sense enough to have kept on tapping and washing out with an antiseptic.

In contrast to that, it might be well to cite a case illustrating what you can do without draining in real pus infections. This was a young girl of 10 years with a knee joint full of pus; it was not seropus, but straight pus. It showed staphylococcus pyogenes aureus and resulted from an osteomyelitis which produced a sequestrum (later removed) and also a huge popliteal abscess.

At the operation this abscess was drained: the pus-filled joint was opened, thoroughly washed with 1:15,000 corrosive followed by salt solution. The joint was then closed tight. There was no sign of infection in the joint from that time. To-day, 4 years later, she has 140 degrees of flexion and, except for certain scars, nothing to show for the old trouble. If I had drained this joint, ankylosis would inevitably have resulted, unless forestalled by a fatal result.

Dr. Nichols has spoken of the necessity of free drainage if one must drain. I should put it even stronger. If you are going to open, open wide — lay the joint wide open.

The case of mine he cited was a streptococcus infection following a punctured wound. It was drained by cutting not only the ligamentum patellæ but by cutting up on either side to the top of the quadriceps bursa, and laying the patella bottom-side up, well up on the thigh, so that the whole joint lay wide open.

The patient was very ill from infection but "came by," and five weeks later I dug out great masses of granulation tissue, cleared the intact cartilages of femur and tibia, sutured the ligaments and after three days removed the temporary drains.

There was no trouble, and five months later, the man had from 45 to 50 degrees of motion and a strong and painless joint. This is an exceptional case, perhaps, but if we thought more about these cases such results would be less unusual.

Dr. Nichols has spoken of the occasional good results of simple drainage. This works at times.

Three years ago a compound fracture of the patella came my way, already septic. The joint was drained merely. In the end he got a fairly competent leg with a little motion. But that same spring, two similar cases on the service similarly treated recovered (fortunately) but with ankylosis.

Three years ago I had a case of streptococcic infection of the hip in a boy of four years, following scarlet fever. The joint was opened and drained, he was too sick to admit of further operation. He recovered without bone necrosis and with about 50 degrees of motion, but not with anything near a normal hip.

Any one of experience can collect these cases, and I could cite many curiosities of recovery, particularly in relation to the smaller joints. But these cases are not the rule, and from a considerable experience I would like to formulate the matter in a way with which I believe the speaker will agree. We should be optimistic in treating these cases, that is, we should often try for results we cannot be sure of attaining. That is, if there is a fair chance we should incise, disinfect, wash and close the joint.

If this is *a priori* hopeless, or if it has been tried and failed, the joint must be laid open! The story comes down to this; either do a little or do a lot! If you have got to open, do it plenty! Do anything but "drain" the joint! Either do a great deal less than that or a great deal more.

ARTICLE XVI.

THE SALVARSAN-CALOMEL TREATMENT
OF SYPHILIS.

BY WILLIAM F. BOOS, M.D., PH.D.
OF BROOKLINE.

DELIVERED JUNE 11, 1912.

THE SALVARSAN-CALOMEL TREATMENT OF SYPHILIS.

THE treatment of syphilis in all its phases is undoubtedly one of the most difficult problems that we have to face. Salvarsan has done much to lighten the task of the practitioner; but, on the other hand, the therapeutic possibilities which this drug brings into medicine have added to the burden of responsibility which rests upon the physician who undertakes the treatment of syphilis to-day. A proper combination of salvarsan and mercury, applied intelligently and in time, will cure every case of syphilis; but the cure requires a great measure of care and patience for its accomplishment. Frequently two or more mercury treatments lead to the disappearance of clinical symptoms; the disease having been apparently eradicated the treatment is discontinued. In the great majority of such cases the disease is not cured, it has simply taken the latent form, which is all the more serious because there is no danger signal.

Another class of cases is characterized by frequent relapses during the secondary stage. But these relapses furnish a better clue to treatment and it is in this class of cases, therefore, that an oft repeated and thorough mercury treatment, extending over a period of years, has led to permanent cures in the past. It is quite certain that one treatment with mercury has never cured syphilis. The medical world has learned its lesson through sad experience and physicians know only too well that the disappearance of clinical symptoms gives no guarantee that the patient is to be spared those most distressing of sicknesses the tertiary, meta-, and

parasyphilitic conditions. The introduction of salvarsan has brought to light an appalling number of just such cases. These unfortunates had well-nigh resigned themselves to their fate and many of them had ceased to be under medical care when the new hope of salvarsan led them again to seek the physician's help.

Few of these uncured cases escape their doom; syphilis is not always given due credit for the part it plays as the primary factor in many sicknesses which lead to death and which involve each and all of the vital organs, and it is this great tendency of syphilis to develop its tenacious latent form which medicine must combat with every means at hand.

Apart from the certainty that genital syphilis with its hereditary and late manifestations is increasing, we must face the fact that there is also an appalling increase of extragenital infection. Fournier, Neisser, Lesser, Scheuer, Bulkeley and others have collected over 30,000 cases of syphilis transmitted through agencies entirely external to venereal contact. As a result of their studies these authors urgently recommended an intermittent intensive treatment of early syphilis with mercury, in the hope thereby to lessen the opportunity for promiscuous infection.

There is, however, only one form of mercurial treatment of syphilis that will accomplish this purpose with any degree of certainty, and that is the intramuscular application of the various insoluble compounds of mercury, such, for example, as calomel and oleum cinereum (blue ointment diluted with olive oil). By using these drugs intermittently and intensively, the German Naval Medical Service was enabled to obtain in many cases a permanently negative Wasserman reaction which remained negative after the provocative salvarsan test (see below).

The following facts concerning the chronic intermittent treatment with mercury were developed in the German navy:

1. It is much more difficult to obtain a permanently negative SR (serum reaction) than to effect a seemingly permanent clinical result.
2. If the treatment is discontinued at an early stage the SR becomes positive again.
3. The rapidity of the return to + SR depends on the quality of earlier treatments and on the duration of the disease; the more inefficient the earlier treatments, the quicker the return of + SR.
4. If all early cases are subjected to an equally intensive intermittent treatment, the clinical peculiarities of individual cases (relapses, malignancy) are entirely eliminated. This is also true of the intensive treatment of the early primary disease, since by means of such "preventative treatment" it was possible to abort the disease in a considerable number of cases. These abortive cases, treated four years ago, show to date an entire absence of clinical symptoms together with permanently -SR.

The abortive measures are not successful, however, unless the intramuscular treatment with calomel is carried out to an intensive degree. This is shown by the cases in which the abortive treatment was attempted with inunction and salicylate of mercury. Such treatment is much too weak ever to effect abortion of the disease. The cases in which the abortive treatment was unsuccessful furthermore show a great tendency to relapses unless they are subjected at an early date to the intensive chronic intermittent treatment with calomel. The less efficient the first treatment of these cases is, the more difficult it is to effect a permanently -SR.

The superiority of the calomel treatment over the treatment chiefly by inunction is shown by the results obtained

in the German navy. At the Naval Hospital in Kiel the treatment in use during the year 1908-1909 was intensive inunction (144 grams) followed by three intramuscular injections of 60 milligrams of calomel each. The results of this treatment were the following in 150 cases:

SR REMAINED +	PER CENT.
Primary cases.....	41
Fresh secondary cases.....	60
Relapses secondary cases.....	78

During the year 1909-1910 the treatment employed consisted of inunction (144 grams) followed by 8 intramuscular injections of calomel of 50 milligrams each, later, of 15 intramuscular injections of calomel in doses gradually diminishing from 70 milligrams to 40, and followed by 2 intramuscular injections of ol. cinereum (100 milligrams each). The results for this year (1909-10) in 130 cases were as follows:

SR REMAINED +	PER CENT.
Primary cases.....	24.
Fresh secondary cases.....	8.7
Relapses secondary cases.....	43.

During the period of intensive intramuscular treatment with calomel the SR remained + in only 8.7 per cent of the fresh secondary cases, whereas with the treatment chiefly by inunction the percentage of the same class of cases in which SR remained + was 60.

According to Gennerich,² chief of staff at the naval hospital in Kiel, the mercurial treatment of syphilis is productive of three classes of cases:

1. *Cures.* With a carefully planned and a sufficiently intensive calomel and ol. cinereum treatment it is possible to abort cases in the primary stage of syphilis. To effect such abortion 3 intensive calomel treatments were found to be necessary. In the secondary stage from 4 to 6 such treat-

ments are required to produce a permanently negative SR. There are no relapses in any of the cases after treatments of this kind, but it takes from a year to a year and a half to effect the cure in secondary cases.

2. *Relapsing Cases.* Less efficient treatment develops two types of relapsing syphilis. The first type is characterized by a long continued tendency to a return of the clinical symptoms, the early reappearance of which betrays the form which the disease has taken. This type is sometimes seen as a consequence of unsuccessful preventative treatment. It appears that the infection becomes more virulent (greater tendency to relapses) if the complete saturation of the system with spirochetes is not prevented at an early date. Cases of syphilis in the eruptive stage which are not intensively treated tend to develop a more refractory and malignant type; and it is this class of cases that furnishes the notorious neuro-recidives. The second type of cases develops in consequence of sufficiently frequent but too ineffective treatments. Such frequent light treatments seem to lead to an increased tendency to relapses. The cases of this type are usually those in which weak doses of bichloride or other soluble salts of mercury have been employed. The effect of this weak treatment seems to be actually to stimulate the development of the spirochetes. On the other hand, there is no doubt that certain cases bear the stamp of malignancy when they are first seen by the physician. These are the cases in which either an absence or a light character of the eruption and other secondary signs has led the patient to defer medical consultation for months.

3. *Latent Cases.* The third class of cases comprises those cases which remain latent after one treatment or several treatments. During the youth of the patient there is no return of the clinical symptoms but the SR remains +. The syphilitic infection in these cases gradually diminishes, owing to the normal processes of repair and absorption in the sys-

tem; the disease is not entirely overcome, however, and the organisms which remain establish themselves in certain favorite sites where they produce in time gummata, sclerosing changes or metasymphilitical conditions. There is, however, also a class of untreated cases which are latent from the start and which are not recognized until the tertiary symptoms appear.

The civilized nations of Europe exhibit an entirely different form of the disease from that shown by the races near to nature among whom syphilis has not been known very long. These races exhibit the disease in its most acute manifestations with a great tendency to relapses but with no tendency to metasymphilis. On the other hand, European syphilis, on account of its frequent passage through the human system and its frequent transmission as an older infection, has lost to a great extent the tendency to frequent secondary relapses; and if it is not treated intensively it will acquire from the start a latent character with the tendency to localization which leads to tertiary syphilis and metasymphilis. The cases of this class are coming to be recognized more and more. Many of the old cases show a —SR, which is accounted for by the localization of the syphilitic process in circumscribed foci and the absence of infective material from the blood.

The use of salvarsan makes it easier to overcome syphilitic infection; but with salvarsan too the treatment must be most intensive. All that has been said of the calomel treatment is also true of the treatment with salvarsan; the insufficient salvarsan treatment is fully as dangerous as insufficient mercurial treatment, possibly it is even more dangerous. The following case is a good illustration:

A young man acquired his initial sclerosis last autumn. On account of the slightness of the secondary symptoms he did not consult a physician until four weeks ago. The physician whom he saw gave him, as the only treatment, one intravenous injection of

salvarsan. Four days ago the patient became stone deaf. It was one of the typical cases of the so-called neuro-recidives which sometimes follow inefficient salvarsan treatment.

Whether or not salvarsan alone is capable of curing syphilis is an open question. Its action is undoubtedly much more powerful and rapid than that of calomel, but perhaps it is not as enduring as calomel action. When an early and effective calomel treatment is used less salvarsan is necessary. In any event, a proper combination of the two drugs makes it possible to cure syphilis in one-sixth the time required when calomel alone is used; and the treatment is much milder. The intensive, chronic intermittent treatment with calomel and ol. cinereum could hardly be carried out successfully with the average American patient; it is difficult enough to convince even intelligent patients of the necessity of the comparatively short intensive combination treatment. The fact that a large number of practitioners are still giving salvarsan in a sort of desultory way, say one injection and then another in two months, with a little mercury by mouth from time to time, does not help to teach the laity the seriousness of the situation. It is to men like Gennerich and Wechselman, who now number their salvarsan-calomel cases by the tens of thousands, that we must look for accurate information in treatment. The lesson they teach is that we must continue an intensive treatment until we obtain a negative SR. The following case will serve to illustrate the sort of thing that is almost the rule and not the exception with us in America to-day.

In the course of an investigation of a possible spread of extragenital syphilis among the employees of a large industrial company I requested that the original source of infection, a young fellow of 21 be sent to my office. When he came he was considerably upset because he had been laid off from work and had been ordered to see me. He told me that he had seen a specialist when he acquired his chancre last January; that the physician in question

had examined his blood and finding it positive for syphilis had given him, last February, an intravenous injection of salvarsan. Then he had taken a certain amount of red iodide by mouth and two months later, towards the end of April, he had received another intravenous treatment. There had been no examination of the blood since the first one. The patient informed me that he was cured and that it was not necessary for him to have further treatment. I saw him about the first of June and I told him that his SR was almost sure to be still positive and that he would probably require more treatment. Needless to say, the SR was still positive. The patient was fast developing a case of refractory latent syphilis.

In secondary cases I usually begin with a calomel treatment of 8 intramuscular injections, 2 of 70, 2 of 60, 2 of 50 and 2 of 40 milligrams. If the patient is afflicted with serious secondary symptoms such, for instance, as laryngeal syphilis with an intense and constant cough and almost complete loss of voice, I immediately give him two or three intravenous injections of salvarsan, three or four days apart, before beginning the calomel treatment. The injections of calomel are given every four to five days, and if the patient's condition allows he receives two more injections of 40 milligrams each when the first 8 are complete. It is not to be denied that the calomel makes the patients feel considerably prostrated in most cases, although some of them bear up remarkably well under the injections. During the calomel treatment the patient must take the very best care of himself; he should stop work if possible, he must go to bed immediately after each injection (I give them in the afternoon) and he must refrain from the use of alcohol for an indefinite period. It is interesting to note how quickly the intravenous applications of salvarsan, which follow the calomel after the lapse of a few days, bring the patient back to a state of comparative well-being. The injections of salvarsan are made, as stated above, in intervals of from three to four days; and five or six injections are given in all. In ordinary cases men receive from 0.5 to 0.6 gram salvarsan at

each treatment, while women are given somewhat less. The calomel must be given as a fine suspension in oil of sesame.

Twenty-five cases of syphilis in all stages that I have treated intensively with salvarsan and calomel all show absence of clinical symptoms and a — SR to date.

The most important cases from a social and hygienic point of view are the cases in which abortive treatment is possible. In these primary cases it is best to begin with three intravenous injections of salvarsan three days apart, and to follow them immediately by five or six intramuscular injections of calomel. During the course of the calomel treatment the patient receives two or three more injections of salvarsan. Each case must be treated on its own indications, but unless the patient is unusually sensitive to mercury it will be possible to complete the entire treatment in from four to five weeks.

Strict individualization is necessary in the treatment of all cases. Each case must be treated intensively until a — SR is obtained. Blood examinations should be made every 14 days. If the SR becomes negative quickly the scheme of treatment should nevertheless be carried to the end. The clinical course of the case must be carefully observed, particular attention being paid to the behavior of the glands.

I think every effort should be made to teach the laity the possibility of aborting the disease in its earliest stages. Neisser, Weintraud, Géronne, Duhot, Stern, Milian, Berger and Gennerich all report cases of successful abortive treatment. Not only is it possible to cure primary syphilis with calomel and salvarsan in one month, the cure has even been accomplished by a single intravenous application of salvarsan. But the cases which have been cured by one injection were seen by the physician at a very early date, before the general enlargement of the glands and before the appearance of the positive SR, with the presence of spirochetes in the lesion, however, to insure the diagnosis. In these cases the

spirochetes disappeared, there were never any secondary symptoms and the SR was negative, remaining negative after the provocatory salvarsan test. A further proof of cure in these cases may be found in the fact that some of them became reinfected with primary chancres after exposure.

The provocatory salvarsan injection furnishes a reliable diagnostic test for latent or uncured syphilis. The test was discovered by Gennerich in October, 1910, a little later and independently of Gennerich,³ by Milian.⁴ Clinical observations with the aid of this test now covering a period of over a year and a half show the following facts:

1. All abortive cases of syphilis treated by the intensive method, which are upward of 4 weeks old and in which the SR was negative before the treatment, show a transitory positive SR. The duration of + SR is directly proportional to the length of time which has elapsed since infection.

2. All cases of secondary syphilis with negative SR show + SR after an intravenous injection of salvarsan. The duration of + SR in these cases is directly proportional to the intensity of the syphilitic process and inversely proportional to the degree of efficiency of previous treatment. If the treatment was poor, the positive phase of the SR may last two to three weeks and even longer. Old tertiary cases, especially cases of arterial syphilis, usually show a + SR lasting 24 hours only, and, as a rule, the positive reaction appears on the second day. Specific treatment of any kind immediately preceding the provocatory salvarsan injection may prevent the appearance of a + SR; but in early secondary cases it has been obtained even when a long continued calomel cure had gone before the making of the test. In testing older cases care must be taken to avoid treatment of the patient to be tested with either mercury or salvarsan for a period of six months or a year previous to the test. The more efficient the last treatment, the longer should be the lapse of time before the test is applied.

3. In latent cases, also, a transitory + SR appears after the provocative salvarsan test. Occasionally the positive phase of the SR endures for some time, but usually it lasts only a day or two.

During the first years of syphilis the provocative salvarsan test is reliable, according to Gennerich, in 100 per cent of the cases. Among the older cases, in which the syphilitic process is often very circumscribed, there are probably a considerable number which will not betray themselves by a + SR even after the most careful provocative test. For the recognition of these cases we are fortunate in now having the "luetin" test of Noguchi.⁵

Noguchi has succeeded in evolving a test which, similarly to the cutaneous test for tuberculosis, will produce an anaphylactic cutaneous reaction in cases of syphilis. Noguchi prepared his material for the test by grinding up pure agar cultures of the spirochete pallida with pure cultures of the same organism in bouillon. He then heated the mixture to 60° C. and added $\frac{1}{2}$ per cent carbolic acid for the purpose of sterilization. After he had determined that his material was sterile he applied it to the scarified skin of patients with syphilis.

Noguchi found that his luetin test was practically always positive in tertiary syphilis, while secondary cases rarely gave the reaction.

It is evident, therefore, that the physician, guided by the Wasserman test for primary and secondary syphilis, the provocative salvarsan-Wasserman test for late secondary and latent syphilis and the luetin reaction for tertiary syphilis, has it in his power to control the disease and to prevent the development of meta- and parasyphilitic conditions.

Much has been written of late concerning the so-called neuro-recidives which have been seen after salvarsan injections. A number of writers, following the lead of Finger,

have endeavored to attribute these cases of sudden blindness, deafness, or other nervous disturbance to arsenical poisoning from salvarsan. That these accidents cannot be due to salvarsan or any of its decomposition products, such as arsenious acid, is shown by the following facts:

1. Neuro-recidives are unknown in the modern treatment of yaws, trypanosomiasis, relapsing fever and other diseases (except syphilis) which are now uniformly treated with salvarsan.

2. Neuro-recidives are usually promptly cured by further salvarsan treatment.

3. Neuro-recidives are never seen in cases of syphilis which are treated intensively with salvarsan from the start.

4. The symptoms apparent in the neuro-recidives are not those of arsenical poisoning. In cases treated with salvarsan which have died, no arsenic could be found in the brain and spinal cord, the organs which are affected in the neuro-recidives.

As a matter of fact, salvarsan, with the sole exception of neo-salvarsan, is the most innocuous compound of arsenic known. In the form of salvarsan seven times as much arsenic may be introduced into the system without producing intoxication as could be given in the form of potassium arsenite (Fowler's solution).⁶ Salvarsan seems to be truly "parasitotropic" without having, to any marked degree, a tendency to cause degenerative changes in the organs.

When salvarsan is given properly and with due knowledge of its properties and when it is given in sufficient quantity to avoid neuro-recidives, it is not a dangerous drug. Ehrlich warns us not to give salvarsan in cases with an easily excited neurocardiac system, in cases with arterial degeneration or aneurism, in cases with a history of cerebral hemorrhage, in diabetes, in nephritis, in cases of gastric or duodenal ulcer and in old people. I feel that this warning must not be taken too literally since, to date, many seem-

ingly hopeless cases included in the list have promptly recovered with salvarsan medication. It behooves the physician, however, to be very careful in his treatment of such cases. When any of the conditions, enumerated above, are present it is best to give small doses of salvarsan at first. If these are well borne, the physician may proceed gradually to higher dosage. Doses of 0.1 to 0.2 gram are safe in practically all cases.

Salvarsan is best given intravenously. The intramuscular method of application, which was first employed, has many serious drawbacks. It is very painful and prostrating to the patient and the concentrated alkaline solution which is commonly used for intramuscular application often produces distressing sloughs. The conditions for absorption are uncertain; in unfavorable cases some of the salvarsan may be retained in the place of application until it decomposes and arsenical poisoning may result. In the intramuscular method of application, moreover, the dosage is very inaccurate at best. But perhaps the most important objection to the intramuscular method is found in the fact that it is quite impossible with this method to introduce a sufficient amount of salvarsan into the circulation at one time even distantly to approximate to Ehrlich's object of producing complete sterilization by flooding the system at once with salvarsan. The intravenous method, as I stated a year ago,⁷ is, therefore, the only rational method of application for salvarsan.

Since reporting my observations tending to show that salvarsan may be retained in the system for a considerable length of time even when it is given intravenously,⁷ I have been able repeatedly to detect arsenic in the urine several months after its intravenous application. Fischer and Jessinonek go so far as to say that they found arsenic in the urine of a patient $7\frac{1}{2}$ months after his last intravenous infusion.

For the intravenous injection it is best to use a very

slightly alkaline solution. The acid solution is undoubtedly more effective, but it is also much more toxic, according to Hering⁸ ten times more so, than the alkaline solution.

The intravenous application of salvarsan should be followed by at least eight to ten hours' rest in bed. On this account I usually give my infusions at six o'clock in the evening, on the empty stomach, and keep the patient in bed till the next morning. The patient's comfort is insured by a 0.5 gram dose of veronal sodium, which he takes soon after the injection. This dose may be repeated once and even twice during the night, if necessary.

Out-patient treatment by intravenous infusion of salvarsan is decidedly unadvisable. Treupel and Levi⁹ saw some severe collapses following out-patient intravenous treatment and they have consequently abandoned it.

The best form of apparatus to use for the infusion is one provided with a needle and canula. The canula is passed through the needle and it projects beyond the point thus protecting the wall of the vein from puncture. It is this secondary puncturing of the vessel wall which is the usual cause of failure in intravenous technique. If the needle has been properly inserted into the vein the use of the canula makes it impossible for the infusion to fail. It is best, furthermore, to allow the salvarsan solution to flow slowly into the vein by gravity, rather than to force it into the circulation quickly and under considerable pressure. An apparatus of my design for the intravenous application of salvarsan by gravity that is provided with a needle and canula, is in use in the wards of the Massachusetts General Hospital.*

Certain difficulties which have been associated with the preparation and application of salvarsan, up to the present, will be eliminated by the more general use of neosalvarsan. This compound which bears number 914 in Ehrlich's re-

* The apparatus is manufactured by the Randall Faichney Co., Boston.

markable series is a formaldehyd-sodium-sulf-oxylate of di-oxy-di-amido arseno-benzol or salvarsan. Neosalvarsan is a sodium salt which is easily soluble in water with a neutral reaction, therefore its preparation for use requires no skill, since simple solution in water is all that is necessary. By its use even the slight reactions sometimes seen after salvarsan will be avoided. Neosalvarsan is somewhat less toxic than salvarsan and it seems to act a little more promptly. It may be given intravenously every second day in doses up to $1\frac{1}{2}$ grams. Six grams of neosalvarsan are equivalent to 4 grams of salvarsan.

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ARTICLE XVII.

THE FILTERABLE VIRUSES.

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THE FILTERABLE VIRUSES, A SUMMARY.

THE list of diseases due to the so-called filterable viruses includes many of the most important diseases of man and animals. Our knowledge of the existence of filterable viruses dates from 1898, and some idea of the activity in research, stimulated by the finding of the first filterable virus, is given by the number of diseases — thirty — now known to be caused by them.

By the filterable viruses we mean microörganisms which will pass through filters, the pores of which are too small to give passage to bacteria. Such filters are the well-known Berkefeld filter, made of diatomaceous earth, and the Chamberland filter, made of unglazed porcelain. Both types of filters have been used for many years for the purpose of separating bacteria from their products of growth. Bacteria-proof filters furnish an important means of studying the toxins, which may be removed by filtration from cultures of bacteria, and from lesions where the specific cause has not been cultivated.

In 1898 Loeffler and Frosch, while trying to obtain toxic material for immunity experiments, from lesions of foot and mouth disease, discovered that the virus of the disease would pass through the finest porcelain filters, and this observation marks the beginning of the series of investigations which have been made with respect to the filterability of viruses. Independently and shortly after Beijerinck discovered that a disease of the tobacco plant, the mosaic disease, was produced by a virus which would pass through the finest porcelain filters. He believed the virus to be in a

fluid state "contagium fluidum," and through reasoning, not now tenable, convinced himself that living matter could exist in an unorganized or fluid state. Following Beijerinck's publication came one by Iwanowski who made and substantiated the claim that he had previously, in 1892, demonstrated the filterability of the virus of mosaic disease. From this time on data respecting the filterability of viruses accumulated rapidly.

The term "ultramicroscopic" is often used as synonymous with "filterable," but filterability does not necessarily mean that the virus cannot be made visible in some stage of its growth, or by methods of illumination now employed. There is one virus—that of the pleuropneumonia of cattle—which passes through the Berkefeld and coarser porcelain filters, which may be seen by direct observation with the best optical equipment, using transmitted light, with a magnification of 1500 diameters. The dark field method of illumination and the ultramicroscope, of course, will demonstrate particles in fluid which are but a few times larger than protein molecules. The delicacy of the ultramicroscope is such that repeated distillation in silver vessels is necessary to obtain water free from particles which disperse light. With this method of illumination small particles appear as luminous points, and it is, of course, impossible to distinguish minute organisms, such as filterable viruses, from the myriads of particles which are necessarily contained in fluids available for study.

The possibility of studying the visible viruses by direct methods of illumination seems to be hopeless inasmuch as the very nature of light limits the size of objects that may be studied to two-tenths of a micron. Effort to overcome this difficulty has resulted in the apparatus which employs light of short wave length—ultra-violet light having half the wave length of yellow light. This actually doubles the resolving power of the microscope, reducing the limit of size of parti-

PROPERTIES OF THE FILTERABLE VIRUSES.

Virus.	Temperature destroyed by:	Drying.	Putrefac- tion.	Glycerine resists.	Phenol.	Antiformin.	Saponin ricin bile.	Disinfectants in general.	Artificial immunity.	
									Active.	Passive.
1. African horse sick- ness.	Heat (moist), 70° C. in 10 min.	Resistant.	Resistant.	Resists 25% for 2 to 3 weeks.	.....	.....	.....	.....	Yes.	.....
2. Swamp fever of horses.	Heat, 50° C. in 1 hour. Cold, 0° C. in 7 weeks.	Resistant.	Resistant.	.....	.....	.....	.....	.....	Negative results.	.....
3. Catarrhal fever of sheep.	Resists room tempera- ture for 467 days.	.....	Very resist- ant.	50% for 2 days 25% for 2 yrs.	Resistant up to 2 1/4%.	.....	.....	Resistant to 1% for- malin, 25 days, 2% boric acid, 7 days.	Complete.	Partial.
4. Yellow fever.	Heat, 55° C. in 10 min.	.....	.....	.....	.....	.....	.....	.....	Complete.	.....
5. Dengue fever.	.....	.....	.....	.....	.....	.....	.....	.....	Yes.	.....
6. Sand-fly (3 day) fever.	Resists room tempera- ture 3 1/2 days.	.....	.....	.....	.....	.....	.....	.....	Yes.	.....
7. Typhus fever.	Heat, 52° C. to 55° C.	.....	.....	.....	.....	.....	.....	.....	Yes.	.....
8. Poliomyelitis.	Heat, 45° C. to 50° C. in 1/2 hour. Cold, -2° C. to -4° C. (resists for weeks).	Very resist- ant.	Resistant.	1 month.	.....	.....	.....	Poorly resist- ant. Menthol destroys. 1% H ₂ O ₂ destroys.	Achieved.	Partial.
9. Rabies.	Heat, 52° C. to 58° C. in 1/2 hour. Very resistant to cold.	Gradual loss up to 14th day (in va- cuo 9 mos.). Resistant for weeks.	Resistant.	10 months.	5% kills in 24° hours.	.....	Destroyed.	Easily de- stroyed few minutes.	Complete.	None.
10. Variola; Vaccinia.	Heat, 57.5° C. in 15 min. Very resistant to cold.	Resistant.	.....	8 to 10 months.	.....	Easily de- stroyed.	Destroyed.	Easily de- stroyed.	Complete.	None.
11. Sheep-pox.	Heat, 48° C. Cold, resists -12° C. to -15° C. for 2 months.	.....	Destroyed.	50% for 12 days.	1 1/2% de- stroys.	.....	.....	Easily de- stroyed.	Complete.	None.
12. Hog-cholera.	Heat, 60° C. to 70° C. in 1 hour. Cold, resists -18° C.	3 days in dry blood.	Destroyed in 8 days.	5% solution, proportion 2:5 for 8 days.	Resists 2%.	2.5% re- sists for 2° hours.	.....	Resistant (1-2000) cor- rosive for 8 days.	Complete.	Achieved.

13. Foot-and-mouth disease.	Heat, 50° C. in 10 min. Cold, -8° C. to -9° C.	Destroyed in 24° hours.	Resistant.	1% in 1° hours.	.....	.....	Easily destroyed.	After recovery, not artificially.
14. Fowl pest.	Heat, 55° C. in $\frac{1}{4}$ hour; 60° C. in 1 min.	Very resistant.	Resistant. 9 mos. very resistant.	.....	.....	0.5% sapo- nin in 30 min.	Fairly resistant, 1% corrosive destroys in 30 minutes.	No data; usually fatal.
15. Fowl diphtheria.	Heat, 60° C. in 3 hours. Cold, -12° C. in 5 wks.	Very resistant.	Resistant, weeks.	Resists 2%.	Very resistant 10% in 24° hours.	Resistant.	Resistant.	Achieved.
16. Chicken sarcoma.	Heat, 55° C. in 15 min. Withstands repeated freezing and thawing.	Very resistant (7 mos).	Resistant in 50% for 1 month.	Destroyed by 0.5%.	.....	Easily destroyed.	Easily destroyed.	.....
17. Cattle plague.	Heat, 58° C. to 60° C.	Four to twelve days only.	Resistant. Resists 8 days.	.....	.....	Destroyed.	Easily destroyed.	Complete.
18. Novy's rat disease.	.....	.....	Resistant.	.....	.....	.....	.....	.....
19. Trachoma.	.....	.....	.....	.....	.....	.....	.....	Natural only.
20. Distemper of dogs.	.....	.....	.....	.....	.....	.....	.....	.....
21. Infectious stomatitis papulosa (cattle).	.....	.....	.....	.....	.....	.....	.....	.....
22. Infectious agalactia	.....	.....	.....	.....	.....	.....	.....	.....
23. Pleuropneumonia of cattle.	Heat, 58° C. Cold, resists -5° C. to -6° C. for a year.	.....	Very resistant.	Resists $\frac{1}{4}$%.	.....	.....	.....	Achieved.
24. Molluscum contagiosum.	.....	.....	.....	.....	.....	.....	.....	Slight, but no agglutination or bactericidal action.
25. Verruca vulgaris...	.....	.....	.....	.....	.....	.....	.....	.....
26. Measles.	Heat, 55° C. in 15 min. Freezing, resists at least 24° C.	Resists at least 24°.	.....	.....	.....	.....	.....	Complete.
27. Scarlet fever.	.....	.....	.....	.....	.....	.....	.....	Complete.
28. Guinea pig paralysis.	.....	.....	50% for 10 dys	.....	.....	.....	.....	.....
29. Guinea pig epizootic.	.....	.....	.....	.....	.....	.....	.....	.....
30. Mosaic disease of tobacco.	Heat, 70° C. to 80° C.	Very resistant, 2 years.	.....	.....	.....	.....	Resists 95% alcohol for 10 mos.	.....

cles that may be studied to about one-tenth of a micron. But, as observations with the ultra-violet apparatus can be made only through the medium of photographic plates, it has, as yet, added nothing to the study of the filterable viruses.

There are a few facts which offer encouragement for effort toward demonstrating the filterable viruses. Novy, in 1906, claimed to have shown that the trypanosomes of rats (*T. Lewisi*), and of the African cattle disease (*T. brucei*), and the spirochete of European relapsing fever in man have stages which pass through the Berkefeld filters. The details of his experiments are very meager, and the control methods employed are not stated. Bruce, who worked with cultures of the rat trypanosome, with blood of animals infected with the same and with cattle (*T. evansi* and *T. brucei*) and human (*T. gambiense*) trypanosomes, was not able to confirm Novy's results. Later he attempted to show the existence of a filterable state in tsetse flies which were infected with *T. gambiense*, but with negative results. The important bearing of this question upon the subject of filterable virus impelled me with Mr. Stevens to repeat Novy's experiments with trypanosomes, with entirely negative results. Breinl and Kingshorn, who worked at the Liverpool School of Tropical Medicine, claim to have obtained infective filtrates from the blood of animals containing the spirochete of African relapsing fever. As the spirochete of African Relapsing Fever has an unknown cycle of development in the intermediate host — a tick — these results are compatible with the failure to optically demonstrate this stage. Borrel, working with lymph from the lesions of sheep-pox, obtained a minute flagellated protozoan in filtrates, and he showed that this organism, which he called "*Micromonas mesnili*," would pass through bacteria-proof filters, at least in some stage of its development. There is also another protozoan which has a filterable stage. The only published reference to it is in a discussion by Professor Loeffler who

said that Dr. Spiegel, working in Emmerich's laboratory, has shown that spores of a flagellate, belonging to the genus Bodo, as defined by Dofflein, would pass through Berkefeld filters which prevented the passage of bacillus prodigiosus, even after an hour's filtration. It, therefore, seems possible that at least a few of the filterable viruses, causing disease, may have a stage which is visible by means of the ordinary microscope and particularly those viruses which are transmitted by intermediate hosts, and which are, therefore, probably spirochetes or protozoa.

I have grouped the diseases produced by filterable viruses according to the nature of the host. The largest list is that of domestic animals. It includes pleuropneumonia of cattle, African horse sickness, sheep-pox, cattle plague, hog cholera, swamp fever of horses, an infectious disease of sheep and goats, causing suppression of milk (infectious agalactia), catarrhal fever of sheep, or blue tongue, distemper of dogs, infectious stomatitis papulosa of cattle, guinea-pig epizootic, a peculiar paralysis of guinea pigs and a rat disease. A few diseases are common to man and animals, or at least are intercommunicable. These are foot-and-mouth disease, rabies, and vaccinia and variola. The diseases peculiar to man are yellow fever, molluscum contagiosum, dengue fever, verruca vulgaris, trachoma, sand fly, or three day fever, poliomyelitis, typhus fever, measles and scarlet fever. In birds there are: fowl pest, fowl diphtheria, which has recently been shown to be due to the same virus as epithelioma, contagiosum of fowls, and the chicken sarcoma, which was recently described by P. Rous. In plants there is so far only the mosaic disease of the tobacco plant. The following list contains, as far as I have been able to gather, the important data regarding the properties of the different filterable viruses. Their behavior towards physical and chemical agents is shown in the accompanying table and inspection will show how incomplete this knowledge is.

ANIMALS.

Pleuropneumonia of Cattle^{28, 29, 30, 31.}

Characterization. A very infectious, epizootic disease of high mortality limited to bovine species, and characterized by simultaneous inflammation of the pleuræ and lungs. Suppurative processes in other organs may occur.

Transmission. By contact and by material infected from discharges from the respiratory tract. The virus is not contained in the blood but only in the tissues affected.

The filterability of the virus was discovered by Nocard in 1899. It passes through the Chamberland F filter, but not through grade B. The microorganism has been cultivated, first by Nocard and Roux. It is an exceedingly polymorphous organism. The commonest forms visible at 1500 diameters are spirillar and coccoid in appearance. Curious star-like forms have been reported. The virus retains its virulence in cultures for 6 to 8 days without loss; in glass capsules at 12° C. for one year, frozen at —5° to —6° C. for one year. It resists strong glycerine and $\frac{1}{2}$ per cent carbolic acid solutions. It is destroyed by a temperature of 58° C.

Protective inoculations with pure cultures are successfully practiced. Immunized animals give a slightly protective serum which does not agglutinate or produce lysis of the parasite.

African Horse Sickness^{8, 9.}

Characterization. An acute infectious febrile disease of horses, with edema about the eyes and neck. Recovery or death occurs in a few weeks. Death is usually due to pulmonary edema.

Transmission. Probably by biting insects; experimentally by Anopheles and Stegomyia, and by ingestion of the virus. The filterability was discovered by MacFadyean in 1900.

The virus passes through the Chamberland B filter. It resists thorough drying at body temperature, moist heat at 75° C. for ten minutes and putrefaction for two months. It resists 25 per cent glycerine solutions for three weeks. It is destroyed in solutions of blood and water by incubation at body temperature. No cultures have been obtained. One attack confers immunity but not against large doses of the virus. Artificial immunity is successful through injection of increasing doses of the virus mixed with immune serum.

Sheep-pox^{10, 11.}

Characterization. An acute febrile contagious disease of sheep, enzoötic in Europe, Africa and Asia, characterized by a generalized eruption of papules, vesicles and pustules. Usually not fatal.

Transmission. Contagious. The virus is found in the cutaneous lesions. The filterability was discovered by Borrel in 1902. The virus passes through the Chamberland filters F⁴ and F⁶. It is very resistant to drying and retains its virulence for two years if kept in a cool dark place. It withstands freezing at -12 to -15° C. for two months, 50 per cent glycerine for twelve days, 3 per cent boric acid, 2 per cent salicylic acid and 10 per cent chloride of lime. It loses its virulence progressively when heated at 48° C. It is destroyed by putrefaction, 1½ per cent carbolic acid, 2½ per cent sulphuric acid and iodine at 1 : 10000 dilution.

Cultivation has not been achieved. Inclusions have been described by Bosc, similar to those in variola.

Immunity is complete after recovery. Protective vaccination is successful. Partial passive immunity is achieved by injections of serum from immunized sheep.

Cattle Plague^{12.}

Characterization. An acute, febrile disease of cattle with croupous-diphtheritic inflammation of the mucous mem-

branes, rapid emaciation and bloody diarrhea. Death usually occurs in from four to seven days or there is slow recovery.

Transmission. Takes place by contact and contamination of food with exudate or excreta.

The virus is found in the blood, organs, excreta and discharges from affected surfaces. Its filterable nature was discovered by Nicolle and Adil-Bey in 1902. It passes through the Chamberland F filter.

The virus resists drying for from four to twelve days, putrefaction and $\frac{1}{2}$ per cent carbolic acid when added to blood. The virulence is maintained for from two to three months on hay in dark places. It is destroyed by distilled water in from four to five days, glycerine in eight days, equal parts of bile in two hours, by heat at 58 to 60° C. at body temperature in blood in two to three days. Two per cent carbolic acid and 1 : 1000 corrosive sublimate are effective disinfectants. The virus has not been cultivated.

Immunity follows recovery from an attack; artificially it is accomplished by the injection of small doses of material containing the virus. Passive immunity has not been achieved.

*Hog Cholera*¹⁵.

Characterization. An acute, highly contagious disease communicable only to hogs, characterized by fever, diarrhea and rapid emaciation. The intestinal lesions are characteristic but are probably due to secondary invasion by bacillus suispestifer.

Transmission. Contagious. The virus is in the blood; its filterability was suggested by de Schweinitz and discovered by Dorset, Bolton and McBryde in 1905. It passes through Chamberland filters B and F.

The virus resists drying for three days, preservation at room temperature in liquids for from ten to fourteen weeks, freezing at - 18° C., 5 per cent glycerine for eight days and

1:1000 corrosive sublimate for eight days. It is destroyed by heat at 60° to 70° C. in one hour, in the dry state at 72° to 76° C. in one hour, a 2.5 per cent formaline solution destroys it in fifteen days, a 2.5 per cent antiformin solution in two hours and putrefaction in eight days. It has not been cultivated. Immunity is complete after recovery. Artificial active immunity and partial passive immunity have been achieved by injections of material containing the virus and by sera from immune hogs respectively.

Swamp Fever of Horses ^{14, 15, 16, 17}.

Characterization. An infectious, chronic anemia of horses with fever, prevalent in wet regions of Europe and America. The disease is usually fatal.

Transmission. Probably only by an intermediate host. Experimentally only by injection of blood from an infected horse. It is not communicable to other animals.

The filterability of the virus was shown by Vallée and Carré in 1904. It passes through the Chamberland F and B filters. The virus resists drying and putrefaction. It is destroyed by a temperature of 58° C. in one hour and by freezing at 0° C. in seven weeks. It has not been cultivated. Inclusions in the liver have been described by Ballah,¹⁶ but they are not specific for the disease. There are no observations on immunity to the disease.

Infectious Agalactia of Sheep and Goats ^{3, 18}.

Characterization. An infectious febrile disease of goats and ewes in Italy with local manifestations in the eyes, joints, and udder; usually results in permanent loss of milk and blindness or death.

Transmission. By contact. The filterability of the virus through Berkefeld filters was discovered by Celli and De Blasi in 1904. The virus is found in milk. It has not been cultivated.

*Catarrhal Fever (Blue Tongue) of Sheep*¹⁹.

Characterization. An acute infectious, febrile disease of sheep in Africa; not communicable to other animals, and characterized by congestion and edema of the mouth parts and around the coronets of the feet. Mortality 5 to 30 per cent.

Transmission. Most probably by an intermediate host, possibly by contact. The virus which is found in the blood was shown to be filterable through Berkefeld filters by Robertson and Thieler in 1905 (quotation reference 19). The virus resists 25 per cent glycerine with $\frac{1}{4}$ per cent carbolic acid at room temperature for two years, and 50 per cent glycerine for ten days. In blood it survives 467 days. It resists putrefaction, carbolic acid of less than $2\frac{1}{4}$ per cent, 2 per cent boric acid for seven days and $\frac{1}{4}$ per cent formaline for twenty-five days. It has not been cultivated. Immunity follows recovery. A curative serum is obtained from immunized sheep.

Infectious Stomatitis Papulosa of Cattle^{5, 21}.

Characterization. A benign infectious disease of cattle characterized by a vesicular eruption in the mouth.

Transmission. The natural transmission is not known. It probably only occurs directly by way of the mouth. Experimentally: injection of blood from a case will convey the disease. The filterable nature of the virus was discovered by Ostertag and Bugge in 1906. The virus passes through Chamberland filters; it has not been cultivated. The properties of the virus are undetermined. Artificial immunity has not been achieved. One attack probably gives immunity.

*Guinea Pig Epizootic*²².

Characterization. A very fatal epizootic among guinea pigs observed by Petrie and O'Brien. The disease, though

due to a filterable virus which circulates in the blood, is complicated by an intestinal infection with a bacillus which the authors cannot distinguish from *Bacillus suispestifer*.

The properties of the virus have not been determined. It has not been cultivated. The filters used were Berkefelds.

Guinea Pig Paralysis ²³.

Characterization. This disease is characterized by fever, paralysis of the bladder and hind quarters and emaciation. It lasts from three days to three weeks. The only account of this disease is a short communication made by Römer ²³ at the International Congress on Hygiene in Dresden, 1911.

The pathological changes are somewhat similar to those in poliomyelitis of man. The virus passes through Berkefeld filters. It resists 50 per cent glycerine for ten days. No inclusions are reported. Culture experiments were fruitless.

Rat Disease ²⁴.

At the eleventh annual meeting of the American Association of Pathologists and Bacteriologists, Novy and Perkins described a disease of rats due to a filterable virus. This virus passes through the finest porcelain filters and cannot be deposited by the most powerful centrifugalization. The virus is in the blood. The account of this disease and virus has not been published.

MAN.

Yellow Fever ^{25, 26}.

Characterization. An acute febrile disease with severe blood destruction, endemic in tropical countries.

Transmission. By mosquitoes, the *stegomyia fasciata*. The virus is found in the blood only during the first three

days of the disease. "An interval of about twelve days or more after contamination appears to be necessary before the mosquito is capable of conveying the infection."

The filterable nature of the virus was discovered by Reed and Carroll and their associates in 1901. The virus passes through Berkefeld and Chamberland B filters. It is destroyed by a temperature of 55° C. in ten minutes, and by exposure to the air at a temperature of 24 to 30 degrees C. in forty-eight hours. One attack confers complete immunity. Passive immunity has not been achieved.

Molluscum Contagiosum ²⁷.

Characterization. Infectious epithelial tumors which undergo a central colloid degeneration, thus giving rise to the "molluscum bodies," which may be squeezed out as small, hard white masses. It is a purely local infection.

Transmission. By contact, probably requiring a break in the epidermis for entrance of the virus.

The filterability of the virus was discovered by Juliusberg in 1905. It passes through Chamberland filters (grade not stated). It is found in the degenerated epithelium.

Dengue Fever ^{32, 26}.

Characterization. An infectious febrile disease of the tropics, characterized by an initial fever with erythema and rheumatoid pains in the joints, a short interval of well being, a terminal fever similar to the initial, and crisis. The whole disease lasts from six to twelve days. The mortality is very low.

Transmission. By mosquitoes — the *Culex fatigans*. The virus is in the blood stream. Its filterability was discovered by Ashburn and Craig in 1907. It passes through Berkefeld filters which are impervious to *Micrococcus melitensis*. The properties of the virus are unknown.

One attack of the disease usually gives immunity for one to a few years. The possibilities of passive immunity have not been touched.

Verruca Vulgaris^{1, 2.}

The filterable nature of the virus is claimed by Ciuffo. It is said to pass through Berkefeld filters N and W. (The original papers are not accessible to the writer. Vallillo gives a meager account and the references to the original papers.)

Cultures have not been obtained.

Trachoma^{33, 34.}

Characterization. An infectious, inflammatory disease of the conjunctiva characterized by its resistance to treatment and the production of macroscopic nodules of lymphoid tissue in the palpebral conjunctiva.

Transmission. By contact with the discharges from the conjunctiva. The filterable nature of the virus was discovered by Bertrelli and Cecchetto in 1908. The monkey is susceptible. The virus passes through Berkefeld filters. It has not been cultivated nor have its properties been determined in regard to physical and chemical agents.

Sand-fly Fever or Three Day Fever^{35.}

Characterization. A benign fever of all tropical countries of three days' duration.

Transmission. By the sand-fly — *Phlebotomus pappatacii*.

The virus is found in the blood during the first day of the fever. Its filterability through Berkefeld filters was discovered by Doerr in 1908. It may be preserved outside of the body for three and one-half days, but its other properties have not been determined.

Cultures have not been obtained.

Immunity. Complete after one attack. No effort has been made toward establishing passive immunity.

Poliomyelitis^{36, 37, 38.}

Characterization. An acute infectious febrile disease of children and young adults. Characterized by a rapid atrophic paralysis of groups of skeletal muscles.

Transmission. Unknown. Experimentally by intracranial and intraperitoneal inoculations of the virus. The virus is most concentrated in the central nervous system, but is found also in various organs, the nasal mucosa and the blood. Natural transmission possibly occurs through an intermediate host.

The filterability of the virus was discovered independently and almost simultaneously by Lentz, Landsteiner and Levaditi, and Flexner and Lewis in 1909. It passes through Berkefeld and Chamberland filters.

Cultivation of the virus has not been achieved. The virus resists glycerine for a month, drying over caustic potash, freezing at -2° to -4° C., for weeks, autolysis of tissue and growth of molds. It is destroyed by a temperature of 45° to 50° C. in one half hour. It is easily destroyed by antiseptics; 1 per cent solutions of hydrogen peroxide and menthol are effective.

There are no cell inclusions characteristic of the disease.

Artificial immunity has been achieved through injections of graded doses of the virus. Flexner and Lewis have obtained a slight degree of passive immunity in monkeys.

Measles^{41.}

The filterability of the virus was discovered by Goldberger and Anderson in 1911. The virus is found in the blood, buccal and nasal secretions. It passes through Berkefeld filters. The disease is communicable to monkeys.

The virus resists drying for twenty-four hours, preservation at 15° C. for twenty-four hours and freezing for the same length of time. It is destroyed by a temperature of 55° C. in fifteen minutes. It has not been cultivated.

There are no specific inclusions. Immunity follows recovery; no work on producing passive immunity has been reported.

Typhus Fever ^{39, 40}.

Characterization. An acute infectious disease occurring in epidemics, characterized by suddenness of onset, a macular eruption, prostration and a fairly definite course ending by crisis.

Transmission. Both the typhus fever of Europe and America (Mexican) are transmitted by the body louse (*Pediculus vestimenti*). The filterability of the European virus through the coarser Berkefeld filters was discovered by Nicolle in 1910. Ricketts and his associates did not get infective filtrates with the American virus. Nicolle explains this on the ground that they used the serum from centrifugalized defibrinated blood, while he used the serum from spontaneously coagulated blood, and the most permeable of the bacteria-proof filters. The bacillus of chicken cholera was used for the test bacterium.

The disease is communicable to monkeys. The virus is found in the blood and is most virulent towards the end of the febrile period.

The virus is destroyed by a temperature of 52° to 55° C. It has not been cultivated.

Active immunity is very complete. The blood of animals which have recovered possesses transient protective properties. Ricketts and Wilder found in the blood of patients with Mexican typhus small numbers of minute bacilli. These bacilli measure about 2 by 0.6 microns, but are larger than the bacteria used by Nicolle as controls to his filtration experiments.

Scarlet Fever ^{42, 43, 47}.

Cantacuzene and Bernhardt claim independently of each other to have given scarlet fever to the lower monkeys —

Macacus and Cercopithecus. Landsteiner and Levaditi were not able to confirm these results, though they were successful with chimpanzees.

Bernhardt also claims to have infected monkeys with bacteria-free Berkefeld filtrates. These results have not yet been confirmed. Protozoan-like inclusions, now included by Prowazek among the chlamydozoa, were described by Mallory in 1904, in the skin lesions.

ANIMALS AND MAN.

Foot-and-Mouth Disease ^{6, 7}.

Characterization. A contagious disease of cattle and swine characterized by high temperature and eruption of vesicles in the mouth and around the coronet of the feet. Man is susceptible.

Transmission. Contagious. The filterable nature of the virus was discovered by Loeffler and Frosch in 1898. Cell inclusions are found in the vesicles and Siegel claims to have cultivated these inclusions, which he called "Cytorrhycetes." The virus passes through the coarser grades of porcelain filters. It has not been cultivated. It is destroyed at a temperature of 50° C. in ten minutes, drying in twenty-four hours, five weeks' freezing at -8° to -9° C., and very easily by ordinary disinfectants. Animals after recovery are immune. Protective inoculations are not successful. A certain degree of passive immunity is conferred by injections of serum from immune animals.

Rabies ^{44, 46}.

Characterization. An infectious disease of animals, communicable to man and most common in dogs, characterized by acute onset of mental and nervous symptoms, and paralysis, and high mortality.

Transmission. The virus must enter through a break in the skin and is usually transmitted by bites from infected animals. The virus is found in the central nervous system, secretion of the salivary, lachrymal and mammary glands, in the pancreas, and occasionally in the blood, cerebrospinal fluid and aqueous humor.

The virus resists room temperatures without drying for months, freezing at -16° to -35° C., glycerine for months, putrefaction, and drying if kept in vacuo in a dark place for months.

The virulence is progressively destroyed to a complete loss in fourteen to fifteen days. The virus is destroyed by a temperature of 55° to 58° C. in one-half hour. It is easily destroyed by disinfectants such as 1 : 1000 corrosive sublimate, 1 per cent permanganate of potassium, 2 per cent sulphuric acid, and 1 per cent creolin. It is destroyed by gastric juice in four and a half hours, and by bile in a few minutes.

Cultivation of the virus has not been achieved. Inclusions which are practically specific for the disease were first described by Negri in 1903.

Artificial immunity is satisfactorily accomplished by injections of doses of the virus in increasing strengths. Passive immunity has not been accomplished.

Variola and Vaccinia ^{3, 49, 70, 71.}

Characterization of Variola. An acute febrile disease of man occurring in epidemics, characterized by a papular, vesicular and pustular eruption.

Transmission. Highly contagious. The filterable nature of vaccinia was first discovered by Siegel and confirmed by Negri in 1905. (Quoted from Remlinger (49).) The virus of small-pox was first shown to be filterable by Casagrandi (quoted from Vallillo (3) in 1908). The viruses are now regarded as identical. They pass through Berkefeld filters

and the coarser grades of Chamberland filters. The virus is found in the cutaneous lesions. It resists drying for weeks, and glycerine for eight to ten months. It is destroyed by a temperature of 57° to 58° C. in fifteen minutes and easily by most disinfectants. It is also destroyed by saponin, ricin, bile, taurocholic acid and sodium-oleate. The virus has not been cultivated. Certain forms of inclusions described by Guarneri in 1892 and most carefully studied by Tyzzer (70) and Councilman, Magrath and Brinckerhoff (71) are practically specific for vaccinia and variola. Their parasitic nature is accepted by Prowazek and they are grouped by him with the "chlamydozoa," but to most authorities this interpretation remains unproved.

Recovery from either vaccinia or variola gives complete immunity of long duration to either form of infection. Passive immunity has not been achieved.

BIRDS.

Fowl Pest ^{53, 54, 55, 56.}

Characterization. A disease of fowls, often affecting pheasants, sparrows and rarely geese. Water birds and pigeons are resistant. The disease is characterized by sudden onset, bloody diarrhea and great mortality. It resembles fowl cholera very closely.

Transmission. From feces and nasal secretions of infected birds. The virus is found in the blood stream, nervous system, in the excreta, exudate and nasal discharges. It passes through Chamberland F filters. The filterable nature was discovered by Centanni and Savonuzzi in 1901.

The virus resists glycerine for 270 days. Dry in the spinal cord and liver it survives 200 days. It is destroyed by a temperature of 55° C. in half an hour, at 60° C. it is destroyed in one minute. A 1 per cent solution of corrosive sublimate destroys it in thirty minutes, a 1 per cent sulphuric acid solution in ten minutes. Saponin destroys the

virus in the blood but not in the brain. A temperature of 65° to 68° C. for four hours is required to destroy the virus in the brain.

Prowazek ⁵³ found round and oval inclusions in the brain 1 to 1.5 microns in diameter which by Giemsa's method stained rose yellow and contain a round or elongated bacterium-like bodies. Later he ⁵⁴ included these in the group "chlamydozoa."

Marchoux ⁵⁵ and Landsteiner ⁵⁶ have cultivated the virus in stab cultures of a gelatine medium containing peptone and blood. Immunity of either sort has not been achieved.

Fowl Diphtheria and Epithelioma Contagiosum ^{57, 58, 59, 60.}

Hutyra and Marek ⁵ give Carnwath ⁵⁹ the credit for establishing the identity of fowl diphtheria and fowl pox or epithelioma contagiosum. The picture of the disease varies according to the seat of the lesions and virulence. If on the surface there are produced nodular growths on the skin and mucosa of the neck and head. The growth of the nodules, which are hyperplastic epithelial growths followed by degeneration and necrosis, may be extreme and produce blindness and inability to use the mouth. In fowl diphtheria the proliferation of the epithelial structures is not so marked. The mucous membranes are chiefly affected and there are marked exudative processes, diphtheritic in type.

The air passage may become completely obstructed. Edema of the lungs, necrosis of the liver and serous exudates into the joints and serous cavities may occur. Guinea-fowls, pigeons and pheasants are susceptible.

Transmission. By contact and ingestion of exudates and infected epithelial cells.

The filterable nature of the virus was discovered by Marx and Sticker in 1902. It passes the Berkefeld filters, but not the finer porcelain filters. It resists drying and exposure to

diffuse light for weeks, glycerine for weeks and 1 per cent saponin solutions.

It is destroyed by a temperature of 60° C. in three hours, by freezing at - 15° C. in five weeks, by 1 per cent corrosive sublimate, 1 per cent caustic potash and 1 per cent acetic acid in five minutes.

Bordet claims to have cultivated the virus on a blood glycerine and potato agar mixture, but his claims have been denied by others. (Hutyra and Marek, Bd. 1, p. 423.)

Prowazek⁵⁴ regards the epithelial inclusions as specific organisms and includes them in his group of "chlamydozoa."

Immunity follows recovery and has been achieved by experimental inoculations with the virus. Passive immunity has not been produced.

Rous' Chicken Sarcoma ^{61, 62, 63, 72.}

This interesting infectious and malignant tumor is transmissible only to one strain of fowls. Histologically it is apparently a spindle cell sarcoma.

The virus passes through Berkefeld filters impervious to *Bacillus fluorescens liquefaciens*, but not through the Chamberland F filter. It resists 50 per cent glycerine for one month, repeated freezing and thawing, drying for seven months and heating at 50° to 53° C. It is destroyed by a temperature of 55° C. in fifteen minutes, 5 per cent alcohol and 2 per cent phenol in two hours. It is destroyed by the strengths of chloroform and toluol used to prevent bacterial growth during autolysis and by 0.5 per cent phenol. It is also easily destroyed by saponin and chicken bile.

For transmission the filtrates must be introduced into the tissues. Contact of the virus with injured cells seems essential for tumor production. The subject is still under investigation by Rous and his associates.

SUMMARY.

An investigation of the properties and behavior of the filtered viruses shows that a somewhat significant grouping is possible.

One group is transmitted by intermediate hosts: biting insects of some sort. The mosquito transmits African horse sickness, yellow fever and dengue fever. Sand-fly fever is transmitted by a midge (*Phlebotomus*), and typhus fever by a body louse. Experiments have proved almost beyond doubt that the swamp fever of horses and the catarrhal fever of sheep are transmitted by an intermediate host as yet undiscovered. All of these diseases are essentially blood infections: diseases in which the parasite is primarily a blood parasite. It is quite possible, in the light of recent experimentation and statistical studies, that poliomyelitis requires an intermediate host for its transmission.

One group of diseases requires entrance of the virus directly into the tissue through an abrasion or injury to the surface of the body. These are rabies, molluscum contagiosum, verruca vulgaris, chicken sarcoma and probably trachoma, though it is possible that the last may affect a hold on a normal conjunctiva.

One group is transmitted by contact, which of course means contamination with infected material, such as discharges from the eyes, respiratory tract, surface lesions and excreta. These are: pleuropneumonia of cattle, cattle plague, distemper of dogs, fowl pest, fowl diphtheria, infectious stomatitis papulosa of cattle and the infectious agalactia of sheep and goats. Contagious or possible "air-borne" diseases with filterable viruses are sheep-pox, hog-cholera, measles, foot-and-mouth disease, variola, and scarlet fever.

The methods of transmission of guinea-pig epizootic, guinea-pig paralysis and Novy's rat disease are unknown.

A number of these diseases, under which are included the

most contagious, as foot-and-mouth disease, variola, sheep-pox, hog-cholera, measles and scarlet fever, and others less easily communicated, such as rabies, trachoma, molluscum contagiosum, distemper of dogs, fowl pest and epithelioma contagiosum of fowl, have associated in the lesions, cell inclusions which are more or less specific for the particular disease. Von Prowazek has given particular attention to these cell inclusions and has created for them the name "Chlamydozoa" in the belief that these inclusions are parasitic, a view held by comparatively few pathologists and bacteriologists. In the case of trachoma he maintains that the minute granules, which make up the trachoma body, are the infective agents which pass through the filter. Since McKee and myself have shown that trachoma bodies containing these granules are only the product of pathological mucous secretion, the probability of the inclusions being parasitic is disproved ⁶⁹. It is true, however, that in all the diseases where the filterable virus is contained in cutaneous lesions, special effort must be made to thoroughly break up the tissue cells, before an infectious filtrate can be obtained; this is likewise true of rabies.

Von Prowazek argues that the cells must be broken and the inclusions themselves disintegrated in order that the filterable forms may be set free. In fowl pest the virus has been cultivated which is another argument against the inclusions being parasitic.

In small-pox, sheep-pox and foot-and-mouth disease the viruses are found only in the eruptive lesions and are all resistant to glycerine. Somewhat similar cell inclusions are found in all. In distemper of dogs, fowl pest, rabies, poliomyelitis and guinea pig paralysis the virus shows a preference for the central nervous system; in the first three cell inclusions are found in nerve cells, in the last three the viruses are resistant to glycerine.

Cultivation experiments with filterable viruses have been

fruitless, with the exception of pleuropneumonia of cattle, fowl pest, fowl diphtheria and epithelioma contagiosum and Novy's rat disease. The viruses of these diseases have been cultivated without question. The organism of pleuropneumonia of cattle is exceedingly polymorphous, the commonest forms are small spirochetes which occur singly and in clusters. There are also short coccus-like forms. The other cultivated viruses reveal their presence only through the infectivity of subcultures carried beyond any reasonable limit of dilution from the original.

Some light on the probable nature of filterable viruses, whether protozoan or bacterial, may be obtained from the study of their behavior to various chemical and physical agents. In general, they are destroyed at a much lower temperature than bacteria, but several are rather resistant, particularly the mosaic disease of the tobacco plant, African horse sickness, hog-cholera and fowl diphtheria. They are in general more resistant to the action of glycerine, and here again those associated with inclusions seem to be the most resistant, although we have no data regarding the resistance of the viruses of molluscum contagiosum, verruca vulgaris, trachoma and distemper. In a few instances it has been shown that the filterable viruses are more easily destroyed by certain substances than are bacteria. These substances include saponin, ricin, bile and bile salts, but as the data include only sixteen of the viruses, these tests are not of importance in a general argument. A bacterium, the pneumococcus, is destroyed by bile, a fact which detracts from the value of these tests.

One rather striking feature of the disease with filterable viruses is the nature of the immunity. In nearly every instance immunity is complete and of long duration, and in many instances artificial immunity has been achieved through protective inoculations. In nearly every instance successful passive immunity has not been obtained, which

would indicate that, unlike most bacteria, these viruses produce but little in the way of toxins.

Bacteria play an important secondary role in some diseases caused by filterable viruses; it is even probable that the typical disease picture is produced only by the combined effect of the filterable virus and bacteria. These diseases are: hog-cholera, distemper of dogs, guinea pig epizootic of Petrie and O'Brien and scarlet fever. The association of the bacterium with the disease has been so close in the case of hog-cholera that for many years *Bacillus suispestifer* was supposed to be the sole cause; just as now many believe the streptococcus to be the cause of scarlet fever, and various bacilli the cause of distemper of dogs.

This brief outline and analysis of the subject of filterable viruses would indicate that certain of them are bacterial in nature, because of their resistance to physical and chemical agents, and because four of them have been cultivated. The fact that there is a group that is transmitted only by biting insects would indicate that some of them are protozoal in nature. This seems most probable in view of the filtration of protozoa which has been accomplished by Borrel and Spiegel. The fact that spirochetes have been filtered suggests that certain of the diseases transmitted by intermediate hosts may be due to spirochetes, and particularly some of the diseases of animals. It is not possible to discuss here the classification of spirochetes, whether bacterial or protozoan in nature. For the present it is best with Swellengrebel ⁶⁴ to consider them in a class by themselves.

From the grouping of these diseases, which is possible with respect to the manner of transmission, localization of the virus in the tissues and properties of the viruses in respect to physical and chemical agents, it seems fair to predict that at least some of the diseases which fall into a given group are caused by very similar microorganisms; and that the actual demonstration of the parasite, or its

culture, of one disease will mean a ready solution for others of the same group. It is quite possible that when our knowledge of filterable viruses is more complete, our conception of living matter will change considerably, and we shall cease to attempt to classify the filterable viruses as animal or plant. The extreme minuteness of certain of these viruses, which cannot be thrown down by prolonged centrifugalization with the most powerful machines, and which pass through the finest porcelain filters, suggests that some of their properties may be due to this very minuteness in size; and that like the colloid solution of metals, which behave in some respects like enzymes, a part of their activities and even pathogenic effect may be due to physical phenomena, such as surface action. The extreme minuteness may also account for the contagious nature of certain diseases, because it has been recently shown that minute particles suspended in air or liquid obey the laws which govern the diffusion of gases and of substances in solution in liquids.

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ARTICLE XVIII.

THE SIGNIFICANCE OF SYMPTOMS IN
PULMONARY TUBERCULOSIS.

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THE SIGNIFICANCE OF SYMPTOMS IN PULMONARY TUBERCULOSIS.

As a rule physicians do not attach enough significance to the early symptoms of pulmonary tuberculosis. In a doubtful case the diagnosis is often delayed until definite physical signs appear in the lungs, or the patient is kept waiting until tubercle bacilli are found in the sputum. We all appreciate how difficult it is, occasionally, even for one giving much time to chest examination, to find physical signs in the lungs of some patients who have had pulmonary hemorrhages, elevated temperature, or other symptoms indicating tuberculous infection. After a varied period of time, many of these patients if left to their own devices develop râles in the apices and other signs of infiltration with the subsequent necrosis, which frees the tubercle bacilli.

When this occurs the patient is past the incipient stage even if the diseased area yet be small in extent. As soon as the bacilli are free the opportunity for extension is greater, and perhaps more important still is the fact that the viability of the bacilli is enhanced by having a point of exit which allows the discharge of its own metabolic products. These products when encapsulated in a tubercle tend automatically to hinder, or prevent, further growth of bacilli and the progress of the disease.

When we consider that tuberculous infection occurs in nearly all individuals before they are twenty years old, and but 7 per cent die from tuberculosis, we may truly state that it is one of the most curable of all infectious diseases.

But, however, when we study the cases whose natural immunity is insufficient to withstand the infecting bacilli

and symptoms are produced of such severity that a diagnosis can be easily made, then we have to deal with one of the most difficult diseases to control, and one in which the mortality yet remains high.

One of the ways in which this mortality may be reduced is by a persistent and alert watch for early symptoms. The symptoms to be looked upon as suspicious are loss of weight, weakness, or undue weariness, frequent or prolonged colds, cough, hemoptysis, pleurisy, increased rapidity of the pulse, and an afternoon elevation of temperature, which is sometimes only present after exertion. One, or several, of these symptoms will be present before bacilli can be found, or in fact before there is any sputum to be examined.

The presence of a cough and positive sputum are two factors which cannot be depended upon if an early diagnosis is desired, as both these signs may be absent even when there is well developed tuberculosis, with marked physical signs in the lungs.

All blood spitting which is not explained by cardiac disease, epistaxis or lobar pneumonia should be considered good evidence of pulmonary tuberculosis, unless the location of a bleeding point can be found.

To examine a patient after a hemorrhage and tell him that as no physical signs of tuberculosis can be found in the lungs, the blood must have come from the throat, is a mistaken kindness, which usually leads to dire results.

The method of handling such patients should be reversed and if a careful examination of nose and throat does not reveal the source of blood, the patient should be told that the bleeding must be within the lungs, and means the beginning of pulmonary tuberculosis. Then the patient can take advantage of his good fortune, which is what an early diagnosis ought to be considered. A hemoptysis is often a "life saver," if the patient happens to consult a doctor who is honest in his statements and one who appreciates his opportunity.

A patient at such time is usually willing to drop business and follow the proper treatment. No other symptom so impresses a person with the gravity of his condition, although, as a matter of fact, it is less serious than weakness, or increased rapidity of pulse, which do not attract the patient's attention.

In order to get an idea of the true value of early symptoms in individual cases of pulmonary tuberculosis, we have made a careful study of the histories of 200 cases treated at the Westfield State Sanatorium. One hundred of these cases obtained an arrest of their disease, and one hundred died while under treatment, or within a few months after discharge. We decided to compare these two groups of patients to see if we could determine what symptoms could be considered favorable, or unfavorable, in forecasting a prognosis, or significant in diagnosis.

As the severity of reaction following a tuberculin test is an index of a patient's sensitiveness, it should follow that the immediate symptoms resulting from active tuberculous infection would indicate an individual's natural resistance, or sensitiveness, to the infecting organism. The violence of this reaction would depend upon the natural immunity of the patient and upon the virulence of the infecting strain of bacilli. Other things being equal, early symptoms should indicate the ratio between these two factors.

The onset of these two hundred cases is shown in Table 1 on the following page.

The salient points to be noted in comparing these groups are that, of the arrested cases, in only two was weakness the most prominent initial symptom, as compared with twenty-three patients in the group that died.

Marked weakness as an early symptom means poor resistance, and must be looked upon as of bad omen.

On the other hand, pleurisy and hemoptysis as initial symptoms seem to be of favorable significance, because their

occurrence compels a patient's prompt attention and so he early becomes aware of active infection and the necessity for immediate treatment.

TABLE 1.

Duration of Disease of 100 Cases that Died.

<i>Onset</i>	4 months.	4 to 8 months.	8 to 12 months.	Total 1 year.	12 to 16 months.	16 to 20 months.	20 to 24 months.	Total 2 years.
Cold.....	..	4	5	9	1	3	2	15
Grippe.....	..	1	2	3	..	..	2	5
Pneumonia.....	..	1	1	2	..	..	2	4
Unknown.....	..	1	2	3	..	..	2	5
Cough.....	..	4	16	20	4	5	11	40
Weakness.....	3	3	9	15	4	1	3	23
Pleurisy.....	..	1	2	3	..	..	..	3
Hemorrhage.....	..	..	..	..	1	2	2	5
	3	15	37	55	10	11	24	100

Duration of Disease of 100 Arrested Cases.

<i>Onset</i>	10 to 15 years.	8 to 10 years.	6 to 8 years.	5 years.	4 years.	3 years.	2 years.	1 year.	Total
Cold.....	1	..	..	2	1	2	10	1	17
Grippe.....	1	1	..	..	3	3	2	..	10
Pneumonia.....	1	1	..	..	1	3	2	1	9
Cough.....	1	1	2	2	6	7	12	3	34
Weakness.....	..	..	..	..	..	1	..	1	2
Pleurisy.....	3	1	3	3	3	3	1	..	17
Hemorrhage.....	1	1	1	2	1	2	3	1	12
	8	5	6	9	15	21	30	7	100

TABLE 2.

Complications During Course of Disease.

	Pleurisy.	Hemorrhage.	Larynx.	Bowels.	Ear.	Bone.	Glands.	Rect. Fist.	Kidney.	Lupus.	Appendix.	Menin- gitis.
Arrested	66	67	3	0	2	4	1	2	1	1	1	0
Died	35	39	24	8	4	2	2	1	0	0	0	1

Pleurisy and hemoptysis during the course of the disease are also very frequent in the arrested cases. Pleurisy occurred in sixty-six of the favorable cases, as against thirty-five in the unfavorable group. Hemoptysis was present in sixty-seven of the arrested cases as compared with thirty-nine of the cases who died.

The conclusion that we draw from this table is that the pain from pleurisy and the hemorrhages may each be an indication of the production of antibodies in a sufficient amount to produce congestion and conditions favorable to healing.

Furthermore, the occasional occurrence of these symptoms prolongs proper treatment and we well know that the element of time is a large factor in determining ultimate results.

It is worth noting that tuberculous infections of the larynx were present in but three of the arrested cases, while twenty-four of the patients who died developed laryngitis, although the course of their disease was of shorter duration (average 14 months). This indicates that a low resistance must be the prime factor in the production of laryngitis, as the opportunity for contact infection is the same in all cases of open tuberculosis.

TABLE 3.

Age of Onset by Decades.

	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60
Arrested.....	21	42	24	20	4
Died.....	27	41	24	6	2
	—	—	—	—	—
	48	83	48	26	6

Relation of Measles to Onset.

	Negative in Childhood.			Positive in Childhood.		
	Acute.	Gradual.	Total.	Acute.	Gradual.	Total.
Arrested.....	9	20	29	27	44	71
Died.....	9	15	24	15	61	76

TABLE 4.

Family History.

	Positive.				Negative.		
	Mother.	Father.	Collat.	Total.	Total.	Male.	Female.
Arrested.....	12	7	18	37	63	46	54
Died.....	18	9	17	44	56	45	55
	—	—	—	—	—	—	—
	30	16	35	81	119	91	109

The family history was positive in thirty-seven of the arrested cases, as compared with forty-six of those who died. Although there are 9 per cent more favorable cases with positive family history, the difference is so small that one would not be justified in drawing conclusions that heredity influenced favorably or unfavorably the course of the disease.

TABLE 5.

Nationality.

	Irish	Ameri- can.	French.	Swede.	Finn.	Scotch.	Ger- man.	Pole.	Bohe- mian.	Miscel- laneous.
Arrested:.....	31	30	13	8	6	4	4	1	1	2
Died.....	44	23	10	8	2	4	1	2	1	5

TABLE 6.

Sputum of Arrested Cases.

	Upon Admission.					Upon Discharge.				
	Total No.	Amount.		Bacilli.		Amount.			Bacilli.	
		Absent.	Present.	Negative.	Positive.	Absent.	Decrease.	Same.	Negative.	Positive.
Incipient.....	14	4	10	5	5	5	4	1	9	1
Moderately advanced	42	5	37	9	28	15	13	9	25	13
Advanced.....	44	1	43	8	35	2	20	20	13	29
	—	—	—	—	—	—	—	—	—	—
	100	10	90	22	68	23	37	30	47	43

Note that in this table ten patients had no sputum on admission, although some of them were advanced cases.

Twenty-three had no sputum on discharge. Sixty-eight had positive sputum on admission and forty-three on discharge.

We find that the amount of sputum corresponds with the activity of the disease. If the sputum increases in amount it indicates active tuberculous inflammation and as the quantity of sputum lessens the specimens which contain bacilli become fewer.

It required two examinations to find tubercle bacilli in the sputum of fifty patients, three examinations to find bacilli in the sputum of eighteen patients, four examinations to find bacilli in the sputum of eight patients, and five examinations to find bacilli in the sputum of three patients. During the year antiformin was used in testing specimens of sputum from sixty patients, seven of which proved positive, although bacilli could not be found by other methods.

This work shows the fallacy of putting dependence upon one, or more, negative examinations of sputum, even in cases of open tuberculosis.

TABLE 7.
Râles in Arrested Cases.

	Admission.		Discharge.			Weight at Discharge.		
	No. Râles.	Râles.	No. Râles.	Decrease.	Same.	Gained.	Stationary.	Lost.
Incipient.....	4	10	12	..	2	13	..	1
Moderately advanced	..	42	9	20	13	35	7	0
Far advanced.....	..	44	3	12	29	37	3	4

This table shows that all but four of the cases showed râles after cough. A much larger number failed to reveal râles on ordinary breathing. I wish to emphasize this point. Many diagnoses are delayed because examiners do not insist upon the patient making a short cough at the end of each expiration while auscultation is being done. Even if râles are heard on quiet breathing, this method will

usually bring out râles over a larger area and often show other lobes involved. After râles once appear, and the tissue cells are destroyed, comparatively few cases lose them, except after a long period of time.

In advanced cases râles sometimes disappear following fibroid changes, or the diseased area softens, and being discharged leaves a cavity, with walls that have undergone firm cicatrization.

The presence of dry râles, when considered alone, are of little importance in determining the activity or degree of arrest in an individual case.

The subjective symptoms are of greater value in considering prognosis, as well as in making an early diagnosis, because râles are of comparatively late appearance and remain after the active process heals.

Finally we will consider the pulse rate and temperature. Of the one hundred cases that obtained an arrest, the average temperature for two weeks following admission was from 98.6 to 100 degrees. Eight others had a temperature of from 100 to 101 degrees. Forty-two had practically normal temperatures.

The pulse rate averaged from 90 to 105 in sixty-seven patients. The pulse was below 90 in all but twenty-eight, when discharged.

When a patient's temperature does not remain under 99, after two weeks rest in bed, our experience teaches us that the prognosis for obtaining an arrested condition is extremely poor and, if the temperature remains elevated more than four weeks, that the disease will continue to progress in spite of sanatorium treatment.

The twenty-eight patients whose pulse rate was above 90 upon discharge have, in our opinion, a poor prospect of continuing to hold the degree of arrest obtained, or to further improve. The pulse rate seems to respond very early to the influence of tuberculous infections and remains

the best indication of a patient's resistance throughout the course of the disease.

The points we wish to emphasize are the importance of watching for early subjective symptoms, as by them a diagnosis may be made before ulcerative processes occur to free the bacilli. Also, that the finding of bacilli depends much upon the persistence of the search made for them; and further, that tuberculosis, even in an advanced form, may be present without bacilli appearing in the sputum. Finally in suspicious cases it is better to give patients the benefit of the doubt by telling them that their symptoms indicate early tuberculosis and to prevent further progress it will require a radical change in their mode of living. If a patient is sent to a sanatorium with a doubtful diagnosis, no harm will have resulted, even if it should prove to be a simple bronchitis, or an influenza infection.

The treatment is the same for the tuberculous and the nontuberculous and no harm has yet been known to result to a patient sent to a sanatorium even with a mistaken diagnosis, while irremediable harm results to many patients who are kept waiting for unmistakable symptoms of tuberculosis to develop.

I have purposely omitted to consider in detail the signs to be found by physical examination, because early changes are hard to detect except by specialists, whose field is limited to chest affections. The general practitioner is the one whom nearly all patients first consult. It is on his skill that most patients must rely for an early diagnosis. The family physician whose work is in all departments of medicine does not have the time to devote to careful chest examinations, or the constant practice which is necessary to note slight changes in lung tissue.

He does, however, have the opportunity to note subjective symptoms and his routine work tends to make him a keen observer. Physicians must recognize tuberculosis

when it manifests itself by loss of weight, or strength, or a pulse of 90, or an elevated afternoon temperature, or blood spitting, or pleurisy, or a cough. Any combination of these symptoms which cannot be explained by other causes should be considered sufficient proof of active tuberculous infection.

Failure to make a positive diagnosis from these symptoms is too vital an error for a patient to forgive, but a mistaken positive diagnosis leads to the right treatment, has no fatal sequel and will soon be forgotten.

DISCUSSION OF ARTICLE XVIII.

DR. J. B. HAWES, 2d, Boston: I was very glad indeed when Dr. Chadwick said he was going to write a paper on the importance of constitutional symptoms as compared with local signs in the lungs. I think those of us who have had much experience in dispensaries and out patient departments must be impressed by this fact. The students make the mistakes in diagnosis in two ways—they find a patient manifestly well and strong and healthy who comes in with a nearly normal temperature and pulse, without loss of weight, strength, etc., and, because they find a few constant râles, they immediately make a diagnosis of tuberculosis with utter disregard of the lack of constitutional symptoms; likewise, because they find no physical signs in the lungs, they say the man is all right, although the constitutional symptoms may be marked. That happens in our out patient department again and again. A patient who comes in having lost fifteen or twenty pounds, with a high pulse and perhaps subnormal temperature, but without any marked signs in the lungs, is often called all right by the student as far as tuberculosis is concerned. I was very glad to hear what Dr. Chadwick said about the significance of weakness and getting tired more easily than a person ought to get tired. That is very important, and particularly important if that happens with the pulse running constantly, even when at rest, above one hundred. I think these two points are of the most practical importance.

DR. A. T. CABOT, Boston: It is a matter of importance, this discovery of patients early and one that the medical profession needs to have constantly brought to its attention. The experience that we have at the sanatoria of having patients come there who tell you quite frankly that they have seen half a dozen physicians and have never had the diagnosis of tuberculosis suggested to them makes you feel that there is good reason for constantly harping on the importance of an early diagnosis and the importance of making the diagnosis many times from the constitutional symptoms without the physical signs in the lungs.

DR. I. J. CLARKE, Haverhill: I would like to ask the writer of the paper if he can tell me any one thing that would produce prolonged fever aside from tuberculosis. Is there any particular condition liable to cause a temperature running for weeks that is not tubercular?

DR. CHADWICK: No, I don't think of anything. I know of several instances where a patient was said to have had typhoid two or three times. Patients give us that history, but upon inquiring carefully into the course of the typhoids, so-called, I feel very certain that only one of the two or three times that they were ill was the disease typhoid fever. The others were probably tuberculosis. I do not know of any disease that will cause a persistent temperature for long periods of time other than typhoid except tuberculosis.

DR. CLARKE: The reason for that statement is that it seems to me it is very important in making early diagnosis to furnish the patient with a thermometer and have him bring in his temperature running over two or three days to a week or ten days, four times a day. From the small experience I have had it seems to me that is the strongest symptom we can get as to the probability of the patient having tuberculosis, except where you have other indisputable symptoms.

ARTICLE XIX.

THE TREATMENT OF PULMONARY TUBER-
CULOSIS BY ARTIFICIAL PNEUMO-
THORAX, ACCORDING TO THE
METHOD OF FORLANINI

WITH A REPORT OF TWENTY CASES.

BY GERARDO M. BALBONI, M.D.
OF BOSTON.

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THE TREATMENT OF PULMONARY TUBERCULOSIS BY ARTIFICIAL PNEUMOTHORAX, ACCORDING TO THE METHOD OF FORLANINI

WITH A REPORT OF TWENTY CASES.

PROF. CARLO FORLANINI of the Royal University of Pavia advanced for the first time in 1882 a theory for the treatment of pulmonary tuberculosis by creating a closed artificial pneumothorax on the diseased side. For various reasons he did not make known his first attempts at treatment with an artificial pneumothorax until 1894 when he brought the matter before the International Medical Congress held at Rome. A report of this soon after appeared in the *Müchener Medizinische Wochenschrift*.

Between 1882 and 1894 he made many experiments in immobilization of the lung, both on animals and on human beings. He first used as media various liquids, but, finding that they gave rise to serious disturbances, discarded them and began to experiment with oxygen and air. He found that oxygen was too rapidly absorbed to be of any value and that air gave little better results. He then turned to nitrogen, which seemed to answer the purpose, and has since continued its use.

In 1895 before the Italian Congress of Internal Medicine he reported the first clinical cure of an advanced case of unilateral pulmonary tuberculosis. This was a case that had developed a spontaneous pneumothorax and Forlanini simply maintained the pneumothorax complete by frequent replenishings.

Strangely enough, in spite of his experiments and success, the work of Forlanini remained practically unnoticed and no one, even in Italy, except his assistants, took up the work. He made no other report on his method of treatment until 1906. Before 1890 he began in his clinic at the University of Turin the artificial pneumothorax treatment of tuberculosis, and during all the intervening years continued to use this therapeutical method both in his clinics, at the University of Turin and at the University of Pavia, and in his private practice. During all this time he was gradually perfecting his technique and closely observing the different difficulties that arose, devising methods of overcoming them and closely studying his cases.

It is interesting to know that in June, 1898, an English physician, Dr. Stuart Tidey, noted for his treatment of phthisis by external compression (Piorry method), was present at a clinic given by Forlanini, who, after the clinic, showed him other cases he had under treatment and the pneumothorax apparatus he was then using. In November, 1898, a London paper, the "Outlook," commenting favorably on the results obtained by Murphy on a few cases which he had treated with artificial pneumothorax ends with the following: "Curiously enough, an English physician, Dr. Stuart Tidey, has worked out a similar method independently, and only a few weeks ago discovered it in active and highly successful operation in San Giovanni Hospital, Turin, where it had been instituted nearly ten years before by Dr. Carlo Forlanini." Very little was done in Italy outside of Forlanini's clinic, until lately, when T. Bresciani, Antonini, Orlandini, Fontana, Maffi and others have taken up the work.

This method of treatment has also been adopted and the practice and theory of the method studied by others in countries other than Italy.

AMERICA.

J. B. Murphy of Chicago reported five cases in 1898. These were all unilateral cases and at the time of the report had been under observation but a few weeks. The technique was quite unlike Forlanini's. Murphy used the incision method and introduced large quantities of nitrogen at once, in amounts ranging from 1200 c.c. to 4500 c.c., repeating the injection after two or three weeks. At that time Murphy said: "I do not consider that it is indicated or practical in advanced or chronic tuberculosis, as the fibrous tissue deposited in the lung will not permit the compression of the lung, nor will the pleuritic adhesions allow the injection of gas. So far no conclusions can be drawn as to the ultimate results of treatment."

The next year Lemke reported a number of cases, and continued to treat patients until the time of his death in 1901. Schell of Indiana reported a case of hemoptysis in 1899, in which he had induced a pneumothorax.

Except the little done by Harris and Mary A. Lapham no one seems to have taken up the work from 1899 until 1911 when Robinson and Floyd of Boston reported their series of twenty-seven cases and these clinicians' results were excellent. Robinson who has made a special study of chest surgery improved the technique and simplified the apparatus. The poor results obtained between the above dates, I am inclined to attribute to the technique used and its difficulties.

GERMANY.

In 1906 Professors Ludolph Brauer, Spengler of Davos and Adolph Schmidt took up the work, made clinical reports and advanced theories as to the manner by which this form of therapy acted. With the exception of Forlanini, Brauer has done more in this work than anybody else. These men followed Murphy's technique and at the same time at-

tempted to improve Forlanini's. They treated advanced cases, in which an unfavorable and fatal prognosis had been predicted, yet in many instances with brilliant results, successfully refuting Murphy's conclusions as to its indication and practicability.

Other clinicians have followed Brauer, including Klemperer, Konzelman, Shreiber, Wurtzen, Wellman, Sampson and others, and all have obtained good results. Many have discarded the initial incision and now follow Forlanini's puncture method in preference to Brauer's and Murphy's incision method. Brauer in a recent work on this subject reports 102 cases and his bibliography comprises over 400 works consulted showing the attention this line of work is attracting, especially abroad.

FRANCE.

Dumarest and Dessier were the leaders in France and have been followed by J. P. Murat, Balvay, Argelin and M. Paul Courmont, and others. All of these men have used Forlanini's puncture method with uniformly good results.

DENMARK.

In 1907 Christopher Saugman reported success in a number of cases. Probably he, after Forlanini, has done more than any one else to improve the technique and render the method safe. This clinician improved the technique by the addition of a manometer which measures intrathoracic pressure. It also indicates when the needle is in the pleural cavity by respiratory oscillations shown on the manometer. He also made improvements on the pneumothorax needle. He and his assistant, Begtrup Hansen, have since reported many successes.

ENGLAND.

It is claimed that about 1842 Carson, an English physician, then living in Liverpool, England, suggested a pneu-

mothorax in the treatment of pulmonary tuberculosis. His experiments were, however, those of a physiologist. He showed that animals could live if an open incision were made in the thoracic wall, that permitted external air to enter the thoracic cavity, thus creating an open pneumothorax. But this idea was never really put into practice, or if it was actually attempted in an occasional case, results must have been disastrous, for the time of Carson, 1842, was before the era of antiseptic surgery. The serious nature of an open wound, the grave danger to the mediastinum and the inevitable infection of the pleura must have decidedly prevented second attempts.

Forlanini's therapeutic pneumothorax is entirely different, being based on certain personal views as to the nature of the phthisical process. It is a closed pneumothorax, and is followed by a definite technique, upon which the success of the method depends.

S. Vere Pearson, Herbert Rhodes, Claud Lillingston and Colebrook have recently reported a few cases, but very little has been done there according to available reports.

TECHNIQUE AND PRÉPARATION OF PATIENT.

The apparatus is the one originally used by Robinson, and the pneumothorax needle is the author's modification of Brauer's or Floyd's. Hypodermic and pneumothorax needle are boiled and placed in alcohol.

In all of the writer's cases the puncture method as advised by Forlanini has been used. The preliminary incision method as advocated by Brauer has no advantages whatsoever, even for first introductions, but has some disadvantages in that it is a much more serious surgical procedure. The danger from infection and the possibility of considerable gas escaping into the soft tissue and producing a subcutaneous emphysema, especially after a paroxysm of coughing, might prove uncomfortable for the patient and troublesome

for the physician as well as dangerous. A subcutaneous emphysema would necessarily interrupt the treatment until that had been absorbed. H. Brauns of Hanover has reported a case of suppurating fistula after incision and the production of a pyopneumothorax. Furthermore, the puncture method can be undertaken anywhere that the patient may be without great preparation. If the first puncture fails to find a pleural space further punctures may be made, in as much as they are not attended with discomfort to the patient.

As a rule treatment should not be begun in an office but either at home or in a hospital.

The patients come to the office for treatment in the morning and are instructed to eat a light lunch an hour before coming. The morning is chosen because at that time the patient is rested, usually in good humor and free from excitement. Forlanini's rule against giving women any treatment during the menstrual period, which he has found to increase the susceptibility to nervous symptoms, is also followed. Three or four patients come at the same time, thus permitting the physician to instruct them together and compare conditions.

After a careful physical examination the patient is prepared for treatment. (It is customary to take an x-ray of the chest when the treatment is begun and at frequent intervals during its course.)

The patient is placed in a comfortable recumbent or side position on an operating table or bed, with the arm raised. Any intercostal space below the third rib where the pleura is free and lung margin mobile may be chosen. It is preferable, however, to choose an intercostal space between the fourth and seventh ribs in midaxillary line, where the muscles are thin. It is well to separate the injection points a short distance from one another so that the resulting cicatrices will be small, regular and not massed in a small space.

Having chosen the spot for the puncture the part is cleansed (thorough asepsis being employed) and a solution of from $\frac{1}{2}$ to 1 per cent of Novacain with a few drops of adrenalin is injected under the skin as a local anesthetic, using a common hypodermic syringe with a long fine needle. In some cases, especially if pleural adhesions exist, $\frac{1}{8}$ grain of morphia may be added to diminish the discomfort due to the pressure excited by the nitrogen. Anesthesia is followed a few minutes later by the introduction in a perpendicular direction of the pneumothorax needle. It is inserted slowly, gently and firmly to a depth varying according to the thickness of the tissues. By introducing the needle slowly a chance is given the visceral pleura to retract. After reaching a certain depth the stilette is removed from the needle and the manometer opened. The introduction of the needle is continued gently until the parietal pleura is perforated, which is shown by a lack of resistance and respiratory oscillation in the manometer. One soon learns when the point of the needle reaches the pleural cavity. Possible puncturing of the lung is not a dangerous accident in itself, provided there is no introduction of nitrogen, because the puncture in the lung is immediately sealed up and causes no inconvenience, as has been clinically shown in doing thoracentesis.

When the manometer is opened the pneumothorax needle is held firmly in position. If the point of the needle is in the pleural cavity, and its lumen is not obstructed, the manometer will show the characteristic respiratory oscillations. If the characteristic oscillations are not obtained, the needle is moved gently inward or outward, or the stilette is passed into the lumen to remove any obstruction, until respiratory excursions are obtained, or if this fails after a few attempts, another spot is selected.

In some cases no sooner had the needle passed through the intercostal space than a marked depression was seen in the manometer reading with evident respiratory oscillations,

indicating that the needle was in the pleural cavity. In other cases from the first there was a negative pressure without respiratory oscillations from which it was deduced that the point of the needle had not perforated the parietal pleura. Often I have been surprised at the ease with which the pleural cavity was reached, although I must confess I have had a few failures. In case the needle has become obstructed the manometer remains stationary without any change.

When the point of the needle is in a subpleural space, the manometer may show variations corresponding to the respiratory acts, but the pressure is positive. If in such a case one allows a little nitrogen to flow in, the pressure will actually be higher. In one case (J. A., No. 1) where I allowed 100 c.c. of nitrogen to flow in, the patient felt considerable pain which persisted for some days and necessitated morphia.

If the needle is in the lung there is no negative pressure, nor are there any respiratory oscillations.

Frequently after two or three introductions the negative pressure at the end of the introduction becomes positive, to become negative again before the next introduction.

By adhering to the rule *Never let nitrogen pass into the pleural cavity before the characteristic respiratory oscillations are seen*, danger of fatal gas embolism is absolutely prevented and the needle is held in that position.

At times it has been found difficult to introduce the needle into the pleural cavity without the needle becoming filled with blood. This has happened to me in three different cases namely 9, 12, and 20. The needle was not in a lung vessel because it had not yet reached the pleural cavity as was shown by taking the needle out and after cleaning it introducing it deeper and obtaining the desired respiratory excursions.

On two occasions, cases 9 and 11, the needle had entered

such a large blood vessel that the blood flowed back into the tubing and the manometer showed a rising pressure only.

No attempts were made to introduce nitrogen at such times and patient was told to return in a few days.

When the needle is for a certainty in the pleural cavity, the manometer is shut off and the introduction of gas commenced. Failure to obtain the respiratory excursion may be due to adherent pleurae, point of needle in lung tissue, point of needle in a band of adhesions, point of needle in a blood vessel. The needle may not be deep enough to have reached the pleural space. The needle may be blocked or the apparatus out of order.

At the first introduction small amounts are given. In this series the amount has varied from 50 to 500 c.c. At subsequent introductions larger quantities can be given, as the pleura soon becomes accustomed to this form of trauma and will then tolerate large quantities without discomfort. Later, quantities varying from 1000 to 2000 c.c. of nitrogen have been introduced with absolutely no symptoms. No matter how well a patient stands a first introduction of nitrogen, it is not well to give more than 500 c.c. I have seen two patients in great discomfort after a first introduction of 1000 c.c. With small amounts at frequent intervals the organs in the mediastinum are not subject to sudden displacement, but to a gradual accommodation. In this way, too, the sensitive pleura is not unduly stretched. As pneumothorax is produced gradually there is no sudden evacuation of cavities — instead these are emptied gradually thus preventing the infection spreading to sound lung. (Forlanini and Schmidt report a case each where sudden emptying of cavities infected sound lung.)

There is one exception to the rule of introducing small quantities of nitrogen and that is in hemoptysis. In such cases the pneumothorax is established in an emergency to arrest a serious hemorrhage. The pneumothorax, by

strongly compressing the lung, probably diminishes the arterial circulation, and certainly exerts a favorable action on the accident itself. Forlanini considers it of inestimable value in these cases. In case 14 after establishing a complete compression of the bleeding lung no hemorrhages reappeared although they had been frequent before resorting to the pneumothorax. In this series it was tried in three of the cases that had hemorrhages. In two no hemorrhages have since reappeared and in the other the hemorrhage was arrested but the patient succumbed to a mixed infection and to injuries received in a brawl.

In Case 14 severe hemorrhage was stopped by the introduction of 1800 c.c. nitrogen which apparently immobilized the lung. Four days later motility of lung returned and with it a second slight hemorrhage. 1200 c.c. nitrogen was introduced and this appeared sufficient to immobilize the lung.

Before removing the pneumothorax needle it is well to measure the intrathoracic pressure. If it be found excessive or should the patient complain of excessive discomfort, the pressure may be reduced by allowing the escape of part of the nitrogen thus reducing the tension. The pneumothorax needle is so constructed with two keys as to readily allow this.

After removing the needle pressure should be made over the point of puncture to prevent any escape of gas.

Patients return every day or two until a pneumothorax is produced that completely immobilizes the lung and obliterates the abnormal sounds. After this the patient comes at regular intervals for examination and for the replenishment of the nitrogen lost from absorption, so that the immobilization ought never to materially diminish.

Forlanini says, "It is a fundamental principle of the treatment and a condition *sine qua non* of success that the volume and pressure of the pneumothorax be gradually in-

creased to the obliteration or almost complete obliteration of the respiratory sounds."

I try to wholly obliterate the respiratory sounds, but this is often impossible and naturally difficult to maintain. I am satisfied, however, in certain cases if I can wholly obliterate the abnormal sounds without discomfort to the patient, for then I know that the lung is being immobilized, and taking very little part in the respiratory act. One's practice in this regard must be controlled by the comfort of the patient and especially by the behavior and tolerance of the adjacent organs which are compressed or displaced. The manner in which the other organs are affected furnishes useful indications for the conduct of the treatment. Adhesions which limit the displacement of the heart, for instance, are beneficial, because they permit a pneumothorax at high pressure without displacing the heart much (Case 7). In a case of this series (Case 13) the x-ray showed many adhesions between pleura and pericardium — Dr. Robinson saw this case with me. We were able to introduce 1500 c.c. of nitrogen without perceptible variations of the apex beat. One week previous to this an incomplete pneumothorax from 1000 c.c. of nitrogen had been produced. Two days later I was able to introduce another 1000 c.c. without trouble.

After having established the pneumothorax the neighboring organs naturally feel its effects. If on the left side of the chest, displacement of heart and aorta may be marked and may reach a complete dextrocardia. (Case 14.) For this reason great care must be used and the pneumothorax produced less rapidly.

The other lung feels the effect of the near and pressing pneumothorax more than any other organ. In the treatment with pneumothorax it is likely to show intolerance, especially if diseased foci exist. This is due to the limit of displacement that the mediastinum can undergo in its functional space. In several cases Forlanini had to stop

treatment and resume it with great care and very slowly on account of this displacement.

He says: "To obtain curative effects from the pneumothorax, the pneumothorax must be of a definite volume and be kept at that volume without material variation and interruption, so as to maintain immobilization of the lung during the whole period of treatment. A pneumothorax that does not completely fulfill these conditions will fail in its object. A residual motility of respiration or a recurrence of motility during the treatment would necessarily bring about a persistence or renewal of the destructive process."

This fact is well borne out by cases in this series. In these instances the patients were doing well, while they came every week for examination and replenishment of nitrogen; but when they did not report for treatment for from three to five weeks, they either lost flesh or their cough and expectoration became very troublesome. On physical examination it appeared that the pneumothorax was partially absorbed and its upper limits reached the fifth and sixth intercostal space anteriorly. The pneumothorax was again completed and maintained, then improvement again took place. Only with a well disciplined patient completely under the control of the physician can a complete and successful pneumothorax be maintained and then by frequent replenishment of nitrogen gas. Any patient receiving treatment should understand that it is dangerous for him to leave off treatment at any time and that he must remain under the surveillance of the physician until cured.

The treatment by artificial pneumothorax is distinguished from all other treatments in phthisis by this special characteristic — that it cannot be interrupted without meeting possible serious consequences.

It is evident that after having obtained immobilization there gradually takes place in the lung the process of repair; the contraction of the lung is at first produced only by the

pneumothorax, but later also by the anatomical modifications, that is, the obliteration of cavities and the cicatricial constriction. Now, if in this state of things, the pneumothorax is allowed to diminish, the resulting space not being occupied by the lung which is in part contracted and inexpandive, there is established in the pleural cavity an elevated negative pressure which will add itself as a new factor of perforation to the rekindled destructive process with the loss of immobilization. The obliterated cavities may be reestablished on the edges or walls of these and of those of new formation. The pleuritic decompression will exert a traction outward which being ever placed in a position of increased tension will aid towards perforation.

In private practice to carry on the treatment to the best advantage to the patient, two or more physicians should take charge of the treatment, so that in case one is obliged to give it up through accident, the other can continue it.

Lowering of the diaphragm may give rise because of pressure on the stomach to temporary gastric disorders, which are slight and soon pass off. They consist of slight pain, intolerance of any quantity of food, fullness after meals and even vomiting. (Cases 9-10-12.)

Rapidity of absorption of nitrogen gas differs with the pathological condition of pleura and lung. According to Dr. Dumarest's experience, a healthy pleura absorbs 1000 c.c. of nitrogen gas a month. I am not prepared to accept this. In the diseased condition it is certainly more than this amount. In one of the cases of this series, after the introduction of 2500 c.c. gas, given in divided amounts in five treatments, the physical examination and the x-ray showed the pneumothorax to be complete and only 100 c.c. a week were used to maintain it. In other cases of this series, especially the old advanced cases, the nitrogen was absorbed so rapidly that it was necessary to replace the loss by introductions every few days.

The rapidity of absorption of nitrogen gas is affected by many factors, depending on the pathological condition of the pleura and of the lung involved, on the temperament and activity of the individual and the time of treatment.

The nitrogen is more rapidly absorbed where:

(a) The pneumothorax is not complete and the affected lung still takes active part in the respiratory movement.

(b) The greater portion of the lung is diseased especially if the process is bilateral and there is cavity formation, because a greater amount of nitrogen gas is needed to keep lung compressed. (Cases 7-9-10.)

(c) The individual is active, i.e., working or taking considerable exercise.

Absorption is slower where:

(a) The lung is completely compressed. (Cases 2-4-14.)

(b) The pleura is diseased, as from active inflammatory processes or adhesions. (Case 14.)

(c) There is an active inflammatory process in either pleura or lung.

(d) The patient is quiet.

The nitrogen gas when not held by adhesions in pockets tends to spread in a uniform manner around the lung and keep it compressed.

THEORIES AS TO THE ACTION OF PNEUMOTHORAX.

It is a well-known clinical fact that phthisis not rarely assumes a favorable course if the affected lung becomes compressed by a pleural exudate or by a spontaneous pneumothorax. Forlanini's theory, however, is a complex one based on personal conclusions regarding the nature of the phthisical process, from which it is a natural deduction that the absolute immobilization of the lung necessarily inhibits the destructive process.

The theories advanced as to the cause of action of therapeutic pneumothorax are based on the mechanical

immobilization of the lung and the diminished circulation resulting therefrom.

The compressive action of the pneumothorax brings about its results in accordance with the general precept of surgical therapy, that the reparation of the solution of continuity demands the permanent evacuation of the contents and the bringing of the walls into contact. Forlanini's theory is that the destruction of pulmonary tissue and the resulting cavities are nothing less than solutions of continuity which do not heal because they are never completely emptied, but are, on the contrary, kept irreducibly gaping or open by the relative rigidity of the thoracic cavity. A properly produced pneumothorax frees or separates the lung from the thoracic wall, immobilizes and compresses it, reduces the cavities and empties them and by the coalition of their walls brings about their obliteration and cicatrization.

Another factor also comes into play. Whatever may be the manner of entrance into the lung of the pathogenic germs that cause phthisis, the successive spreading of the process comes about usually through the respiratory tract. Some part of the septic material, as it is being expelled during expiration, is easily drawn back into the lung during inspiration, causing the continuous formation of new foci of infection. The immobilization of the lung overcomes this, the prevailing, if not the only, cause of the continual spreading of the process. Thus the other lung, if not already diseased, is protected, spreading of the infection into other parts of the body, such as larynx and intestines, may be prevented, and a means of combatting the spreading of the disease in general may be secured.

Shingu has shown experimentally in animals that in the compressed lung there is a lymphatic stasis. With the elimination of respiration, which is an essential factor in the maintenance of a regular lymphatic circulation, a stasis

of lymph naturally results. From the lymph stasis a diminution of the absorption of the toxins on the part of the organism and a general improvement in the condition of the patient are produced.

Pigger and later U. Carpi, studying the opsonic index in patients that were treated with artificial pneumothorax, proved that the opsonic index is increased if the diseased lung is immobilized, providing complications of a tuberculous nature do not arise elsewhere. The opsonic index, after certain initial oscillations, reaches in a constant manner a value above normal, which will still show increase corresponding to the new introduction of gas.

H. Brauns of Hanover by using the rapid precipitation method of Spengler, has observed an increased immunizing value of the blood after each introduction of nitrogen.

PATHOLOGICAL CHANGES.

The pathological observations of cases that have come to autopsy, the patients dying of intercurrent diseases, have given anatomical proofs of recovery through cicatrization of all the destructive lesions of the lung which had been treated with artificial pneumothorax. Forlanini, in the microscopical study of three cases noticed that the compressed lung undergoes great modifications. First, he noticed atelectasis; second, an extraordinary tendency to the formation of connective tissue and formation of hard masses about the bronchi, large vessels, and in the pneumonic foci; third, the formation of a capsule about the old tuberculous foci and a tendency to cicatrization; and finally, very few recent tuberculous foci were visible and these contained very few tubercle bacilli and there were no giant cells. Grætz, Drasche and Wurtzen have since confirmed these findings.

It can be readily understood that the anatomical healing of the lesions comes about slowly. It is the work of months,

or even years; it may never come about or it may be partial. There takes place in the lung what is noticed in the articulations and in the bones in cases of tuberculous ostitis and arthritis, with immobilization by apparatus. After a long time the tuberculous tissue is fixed, is organized and is absorbed. At this point the cavity walls are reduced to a state of a granulating wound, coalesce, cicatrize and then the healing process becomes definite. But before granulation and cicatrization and the formation of connective tissue about the tubercle takes place, a long time elapses and during all this time the pneumothorax must be maintained, always at the proper volume and tension, and this means not several weeks, but many months. Here lies the great difficulty, for patients as a rule are very loathe to remain under treatment as soon as symptomatic relief is obtained.

How long shall the pneumothorax be kept up?

Authorities differ, but all agree it must be kept up for a long time. It is not possible to give a definite length of time which will include all cases, so much do conditions vary; but when we consider the gravity of the tuberculous lesions in advanced cases of phthisis and the persistent formation of cavities, it is apparent that it must be kept up for a long time; two years or more. So far, for the most part, only advanced cases have been treated. In 1908 Forlanini advised treating very early cases that had not done well with the present forms of treatment. One of the cases, No. 4 of this series, is of that type. This patient feels perfectly well, and has not received any injections of nitrogen for seven months. The last x-ray showed a pneumothorax fairly complete, but one which had diminished from an x-ray taken two weeks previous. No more injections will be given to this patient unless symptoms should develop, which, from the present condition of the patient, seems unlikely. The pneumothorax is being allowed to absorb gradually.

In another case of this series (Case 3) no injection has

been given since July, 1911. The present condition is satisfactory. No tubercle in sputum, no cough, feels perfectly well.

On physical examination the pneumothorax is completely absorbed, a slight dullness and bronchial breathing at the apex still persist, no râles are heard. The lung has completely expanded. The process is inactive. After a clinical cure has been obtained, especially in early unilateral cases where lesions are slight, provided tuberculosis of the pleura does not exist, the pneumothorax may be allowed to gradually absorb. In such a case there is no reason to fear that any structural changes in the pleura, such as to compromise its function or to bring about adhesion of the layers of the pleura, have resulted from the long absence of contact between the pleuræ or their long contact with nitrogen.

Forlanini, however, insists that immobilization of the lung be maintained so as to prevent a rekindling of the disease as a result of the reëxpansion of the lung. He has cases where he has been maintaining a complete pneumothorax for ten years or more by repeated insufflations in patients who are well and attending to their occupations. Forlanini says that the pneumothorax must be kept up indefinitely in the following cases:

1. In cases of advanced phthisis where there are extensive or disseminated foci, where a good part of the lung is involved and there are no large masses of lung free, lest adhesion of the layers of the pleura, especially if there has been a pleurisy, may result.

2. In cases where the other lung has lesions or is threatened.

3. In unilateral cases where the lesions are extensive, the healed lung is reduced to a contracted cicatricial mass, which cannot reëxpand so as to reoccupy the thoracic cavity when the pneumothorax is absorbed. It is kept up for the purposes of preventing deformity of the thorax and

the subsequent displacement of organs in the mediastinum and in those adjacent to the diaphragm.

He advises maintenance of the pneumothorax because the absorption of the pneumothorax would be of little advantage and because the replenishing of pneumothorax is a measure which is required less frequently as time goes on, and the trouble is amply compensated for by the good results obtained.

During the course of treatment, which may have extended over months, the pleura has been in contact with the nitrogen gas, that is to say, in a medium not physiological. This long contact may cause structural alteration to take place in the parietal and visceral pleura, and these coming into contact, cement and thus partially or totally obliterate the pleural cavity. This would naturally prevent later treatment by artificial pneumothorax or render it more difficult. Evidence shows that the compressed lung retakes its normal function once it has reexpanded. (Cases*3-5-7.) However if the process has not completely healed, the reexpansion of the lung may cause the process to become active again. (Case 5.)

In the tuberculous healed lung there exist abnormal anatomical changes and the lung is the lung of an individual predisposed to the disease because he has been once ill with tuberculosis. The tuberculous process may start up *de novo* a second time. If this comes about, the treatment can be instituted again.

The discontinuance of a pneumothorax especially in unfavorable sanitary conditions will only result in bringing about new areas of infection; while the epithelium of the bronchial mucosa and the pulmonary stroma weakened from the ischemia, from the compression and the inertia, have not taken up their vitality and their ordinary phagocytic function. In this and in bad hygienic surroundings lie the causes of the failures in the cases where the treatment is undertaken for only a short time.

In 1908 Dumarest visited Forlanini's clinic at Pavia. After the clinic Forlanini took him to see a young woman with whose history he had been made acquainted. She had had a complete pneumothorax for the last ten years. During this time she married, had a child and kept a notion store. When he entered Dumarest saw a pretty, gracious person in the best of health. Dumarest asked why he still kept up the pneumothorax. "Ah! me dit-il, c'est qu'une jeune et jolie femme tient a' la symétrie de son thorax."

What influence does the placing at rest of one lung exercise on the other lung? Forlanini has shown that a properly proportioned pneumothorax of one side does not injure the noncompressed lung. If the noncompressed lung is healthy it is capable of carrying on alone the respiratory functions of the organism and doing the work of both lungs. If the noncompressed lung is diseased and the lesions are not so extensive as to allow compensatory respiration for the compressed lung, Forlanini claims that its lesions may heal or be arrested through a mechanism not easily explained, but which is exactly opposite to that by which a cure is effected in the compressed lung, that is, by increased respiration and increased blood and lymphatic circulation. From these things a better nutrition results that protects those portions of lung not yet affected. The site and nature of the lesion in the noncompressed lung is of more importance than its extent. Apical lesions are not as dangerous as lesions situated centrally; an arrested process may carry on the respiratory functions without giving rise to untoward symptoms. The ingenuity of the physician will be taxed to the utmost in dealing with a bilateral case presenting an extensive active process of one lung and an active process in the other especially if the lesions are centrally located and the patient is septic. The lesions may be aggravated by the increased function or by the amount of toxins liberated, so that the

treatment may have to be discontinued for a time, or abandoned, or conducted very cautiously.

Whenever in the noncompressed lung there has been evidence of consolidation, following the injections of nitrogen, the dullness of percussion and the resistance were less marked. Oftentimes the dullness disappeared entirely and the breathing throughout the lung took on a harsh and exaggerated character. The clinical experience of Forlanini, later observations and the cases of this series are the basis for this opinion.

Does a complete pneumothorax inconvenience the patient?

All the cases of this series with two exceptions (Cases 15-20) are working and have kept at some work continuously during the treatment. The cases of this series, of which we possess a radiograph showing a complete pneumothorax, prove that they are not inconvenienced in the least. Some of these patients do the work of a common day laborer.

Case 5 is a furniture dealer, having to carry considerable weight up and down flights of stairs. He has not lost a day's work since he has been under treatment.

Case 12 ran a distance of fifty yards the other day without any inconvenience. This is a thing he had not dared to do since he became sick a year ago.

Case 4 had a complete pneumothorax of the right lung previous to her marriage, that is still complete and she is now seven months pregnant and does all her own work.

Case 1 does all her work.

Case 14 is up and about with a complete pneumothorax of the left lung. He experiences no trouble from it whatever.

COMPLICATIONS DURING AND AFTER INTRODUCTION OF NITROGEN GAS.

It is well to warn patients when beginning treatment of the following complications, so that if they should appear they will not be unduly alarmed.

Massive injections or rapid introductions of gas will cause dyspnea and collapse (Case 12), due to displacement of the mediastinum from pressure on the other lung and heart. Pressure symptoms may be slight at the time of introduction to become marked in a few hours. (Cases 5-19.)

The rapid evacuation of the contents of cavities may cause infection spreading into the other lung. (Forlanini, Schmidt, Brauer.)

More or less pain, especially when there are adhesions and these are being stretched by the pressure of the gas.

The possibility of effusions forming from pleural irritation — the serous form (Brauer, four cases) and the rarely purulent form.

The appearance of blood in the sputum, due to puncture of the lung (Cases 10-11-12-16), appeared immediately but was only temporary. In bilateral cases blood may appear in the sputum where the lung has not been punctured. (Cases 5-12-16 and 20.) The blood made its appearance from 12 to 24 hours after the injection of nitrogen.

Gastric disturbances due to pressure of the diaphragm on abdominal viscera. (Cases 9-10-12.)

A temporary rise in temperature, chills and night sweats probably due to the absorption of a large quantity of toxins.

Emphysema:

During the injection, if the needle is moved outward for any reason or if during the extraction of the needle, unless the valve connecting with the nitrogen gas is closed, gas may pass from the pleural cavity and escape into adjacent tissue of the thoracic wall. Sometimes when the pneumothorax has been established and the gas is at a high pressure, gas may escape through the puncture from the pleural cavity. This accident is most probable if the puncture is of a large caliber. The predominating causes of emphysema are:

- (a) Large wound.
- (b) Lack of tensility of the tissues.
- (c) Excessive thinness of the subject.
- (d) High pressure of the pneumothorax.

An emphysema necessarily compels one to refrain from further treatment until it has been absorbed.

Subcutaneous emphysema:

Subcutaneous emphysema is easily distinguished from normal prominence of the region by tactile and by stethoscopic fremitus. As soon as it is noticed the injection should be stopped.

It causes neither pain nor serious disturbances. A sensation of fullness of the affected part is practically the only subjective symptom. Case 13 (a very thin, weak subject) developed a slight subcutaneous emphysema during introduction of nitrogen. The application of deep pressure over the puncture with a five cent piece wrapped in cotton, immediately stopped the escape of gas. The patient felt no disturbance whatever from the tumefaction.

Cases 9-20 developed a subcutaneous emphysema during the extraction of the needle without producing any discomfort. In all these cases it was rapidly absorbed.

Deep emphysema:

It is more difficult to recognize deep emphysema objectively than the subcutaneous. Only as an exception is it prominently apparent in a particular spot. There is an absence of tactile fremitus. A distinct stethoscopic crepitus exists. Percussion gives a smothered sound but tympanitic in character, high pitched and very variable over a short period of time.

In four cases pressure symptoms developed, accompanied by a feeling of tightness about the chest and neck, sore throat, difficulty in swallowing and breathing, and a changed

voice which was characterized by a nasal twang and pains across the chest. Spontaneous pains are more frequent and are markedly felt. These pains will last for a few days, gradually disappearing and diminishing in intensity. Two other patients, Cases 2 and 10, developed these latter symptoms. The patients were rather alarmed, more on account of the changed voice and the constriction about the throat than on account of the pains. In fact Case 5 left off treatment after that and did not return again for several months. Case 11 sent for me in the evening, being greatly worried on account of the feeling of tension about the neck and the slightly changed voice with a nasal twang. These symptoms disappeared within three days in all cases.

A large quantity of nitrogen in these four cases was introduced at a high pressure.

Pleural reflex. Eclampsic pleurisy:

The pleural reflex has been carefully studied by French clinicians, especially M. Roch and V. Cardier (Lyon). There are in the literature reports of sudden deaths by merely puncturing the pleura. The phenomenon consists of epileptiform attacks with loss of consciousness or else attacks of paralysis; as a rule these symptoms disappear entirely or may leave a trace of paralysis for a short time.

Experiments on animals with chemical substances have shown that by anesthetizing the pleura this reflex can be prevented. Forlanini cites a case where as soon as the needle had punctured the pleura and before the introduction of nitrogen, the patient became pale, there was cloudiness of mind and a heavy sensation in the arm, so that he was unable to raise it, but all these symptoms disappeared in the course of half an hour. Patients are apt to have recurrence of the reflex at subsequent punctures if they have shown it once. Forlanini, by using stovaine as a local anesthetic before injecting prevented the coming on of the

reflex. But this author does not as a routine make use of a local anesthetic. Brauer recommends the subcutaneous injection of 1-2 cgr. morphia about one half hour before puncturing the pleura.

Robinson has clearly shown that the use of a local anesthetic (preferably novocain) in all operative procedures on the chest prevents the reflex. The pleural reflex has never been met in any of these cases as the technique recommended by Robinson has been followed.

For details regarding the pleural reflex the reader is referred to the works of M. Roch, V. Cordier and Forlanini. In general it may be said that the predisposing causes are:

- (a) General weakened condition.
- (b) Excitability and weakness of nervous system.
- (c) Fear of the injection.
- (d) The menstrual period.

Gas embolism:

Gas embolism ought to be entirely avoided. It is possible that on account of pain or a paroxysm of coughing or a sneeze the needle may involuntarily be thrust with a jerk a certain depth into the lung (as in a case of this sort in Brauer's hands). It may enter a blood vessel and before the nitrogen gas can be shut off or the needle pulled out, cause a fatal gas embolism.

During Forlanini's long experience with the treatment it has happened twice. This was when he began the treatment and the accident was the cause of his inventing a safety syringe which he thereafter used.

There are reports of cases of gas embolism ending fatally in the French, German, Italian and American literature. It appears that in all these cases the accident occurred not at a first introduction but at subsequent ones, a fact well worth remembering.

Three cases were reported to Brauer by other operators. In one case a collapse took place which was quickly followed by death. In the other two cases after rallying from the collapse a hemiplegia, cardiac weakness and unconsciousness developed, and the symptoms continued until death ensued.

Two of these cases came to autopsy and clearly showed gas embolism. In one case the needle had been introduced into the lung tissue and had produced a tear in the respiring lung the size of a ten pfennig piece.

It seems evident that these fatal cases would not have happened if, as Forlanini insists, the safety syringe had first been used or the manometer which Saugman added to the apparatus had been brought into play.

"No gas should ever be allowed to pass into the pleural cavity unless marked respiratory oscillation have been obtained. Only then can the operator be sure of having entered the pleural cavity."

In cases where a free pleura exists and mobility of lung margin is demonstrable from the physical examination, there is no danger of gas embolism from needle puncture. The danger of gas embolism may be present in a relatively small number of cases but these can previously be diagnosticated as "dangerous" or at least "suspected."

Such cases are those in which,

(a) The pleura is not normal.

(b) The pleural cavity is obliterated.

(c) The adhesions and pleuritic inflammatory neoformation exist. The older and larger these neoformations are the greater, and more imminent is the danger on account of the blood vessels they contain.

(d) The pneumothorax consists of a thin stratum of gas.

(e) Large bands of pleura containing lung tissue exist, which are stretched across the wall of the thorax and compressed lung to the opposite side crossing the cavity of the pneumothorax. — Forlanini.

RESULTS — IMMEDIATE AND REMOTE.

The results are in proportion to the degree and duration of the collapse obtained. The symptomatic relief in many cases is soon evident. The effect on the temperature is remarkable especially if that portion of lung which is the cause of the temperature becomes compressed. In Case 14, on the third day after the first injection of nitrogen gas, the temperature was lowered from 102 degrees to 99 degrees. The temperature stayed down, reaching normal on the sixth day. The night sweats also disappeared. In Cases 1-5-7, soon after instituting treatment, the temperature came to normal and there was also a disappearance of the night sweats. This is ascribed to the rest given the organ and to the lymph stasis, causing a diminution in the absorption of toxic products.

The sputum was at first increased and became easier to expel; it gradually diminished and in some cases disappeared entirely and with its disappearance there was a marked improvement in the cough; where it was abundant at first, it became less troublesome and in some cases disappeared entirely. Most of the cases have no cough to speak of and they raise very little sputum and that in the morning.

As the sputum and cough diminished, there was an improvement in the general condition of the patients. As a rule all the patients gained in weight. Case 11, in particular, has gained twenty pounds under treatment.

Three cases, 8-15-16, lost weight at first but soon regained the loss and have remained stationary. Case 15 is gaining now. The only case that has lost ground is case 10; an explanation of this is given elsewhere.

The only case that was not helped was case 18, an acute bilateral one with hemorrhage.

Three of the cases show no tubercle bacilli in the sputum, are in excellent physical condition and are attending to their ordinary occupations.

Definite clinical recoveries have been reported by Forlanini, Brauer and others. Recovery is obtained after a variable period and is in proportion to the extent of the lesions, but generally in not less than a year. It may be well to continue the treatment indefinitely. The oldest and best results are those of Forlanini. Other authors, especially Lemke, Brauer and Spengler, Saugman, Wellmann, and Dumarest, have important statistics, which altogether comprise several hundred cases. Cases of this series 1, 3, 4 show no signs of disease now and are enjoying good health.

DISADVANTAGES.

Up to now we have considered the advantages of an artificial pneumothorax. It also becomes necessary to consider its disadvantages.

Having abolished the function of an entire lung, the non-compressed lung must do the work of both. In general, individuals affected with tuberculosis are readily predisposed to infection and may easily succumb to bronchial disease. If, for instance, a patient with an artificial pneumothorax becomes ill of pneumonia or bronchitis of noncompressed lung, what will happen? The prognosis must necessarily be grave. Touissant, in his *Thèse de Paris*, 1880, says, "Any infection of expanded lung that from the time of the formation of a pneumothorax has the responsibility of maintaining life is an accident of the greatest gravity." One of Forlanini's cases successfully went through a serious case of bronchitis of noncompressed lung. Case 1 of this series recovered from a bronchitis of three weeks' duration this last winter. Case 14, also of this series, had a bronchitis, due to pressure from the mediastinum, that cleared up in a week. But these cases, though they show what a patient can successfully pass through, do not in the least lessen the danger. It is possible that the increased function of the noncompressed lung may

give an increased amount of immunity against infections of that lung.

The heart has to do more work and, besides being displaced by the pneumothorax or by the retraction of the lung, encounters increased resistance in the lesser circulation in proportion to the suppressed circulatory area on account of which the right ventricle must double its work. It is certainly a treatment that is not to be undertaken in subjects with any cardiac or renal disease.

The patient practically binds himself to the physician for an indefinite period, and it always remains an operative procedure with the possibility of an accident.

INDICATIONS.

In any case the treatment by artificial pneumothorax ought only be resorted to after having given a fair trial to other well-known forms of treatment. If then the patient's condition does not improve or show signs of extension or the patient's condition immediately becomes worse it is to be undertaken at once.

CONTRAINDICATIONS.

Union of the leaves of the pleura and extensive pleural adhesions.

The acute bilateral forms of phthisis.

Grave lesions in other organs, as cardiac or renal.

Extensive destruction of pulmonary tissue in the lung which is in better condition.

Emphysema and splachnoptosis.

PROVISIONAL GROUPING OF THE CASES FROM THE LITERATURE AND FROM THIS SERIES WHERE ARTIFICIAL PNEUMOTHORAX HAS PROVED OF VALUE.

Group 1.

Unilateral Cases. The unilateral cases with free pleura, no matter how far advanced, provided there are no complicating diseases, represent the ideal type for treatment.

Group 2.

Advanced Bilateral Cases. Treatment may be attempted in many advanced bilateral cases, because the patient has everything to gain and has nothing to lose. In cases where the lesion in the other lung is primary and circumscribed, recovery is still possible, or it may be arrested, or the prolongation of a state of well-being may result. But even if the lesions are advanced, good results may be obtained and exceptionally unexpected amelioration may take place. In almost every case you may expect symptomatic relief, which in the phthisical, when every other means used has failed, represents a benefit to the patient.

Group 3.

Exthrathoracic tuberculosis, such as laryngeal and intestinal tuberculosis, do not contraindicate in themselves the pneumothorax. When these lesions are secondary to the lung, the suppression of the tuberculous lung may favorably influence their course. There are reports of recovery of tuberculosis of the larynx. My experience has been limited to cases 6 and 13, which were very advanced bilateral cases and in which treatment was attempted as *ultima spes salutis*. They were made better for a while, but finally succumbed to the throat lesions.

Group 4.

Pleural Adhesions. This represents a group of cases extremely difficult to treat, but which are not by any means hopeless; if you can even partially immobilize the lung, you have gained something. It is possible to inject gas in various places and thus form multiple sacks of gas, and these compress the lung. Of course a much higher pressure has to be used that may not be tolerated by the patient, and, besides, the nitrogen gas will be absorbed much more quickly, so that frequent replenishments will be necessary. Treat-

ment will be long, tedious, uncertain and, at times, discouraging. Progress will be slow, and results will be partial. If a substance could be injected into the adhesion that would dissolve them, that would greatly facilitate matters, but a substance that dissolves adhesions must also dissolve other tissues. Holmgren has suggested that the insufflations of gas in case of pleural adhesions be preceded by the introduction of physiological salt solution, so as to stretch or loosen these.

Group 5.

Hemoptysis. If the hemorrhage is from one lung and a reasonable portion of the other lung is sound, enough nitrogen gas is injected to immobilize the lung, and the hemorrhage will be controlled. Cases 5-11-14 illustrate this well. Case 14 had been under the ordinary forms of medical treatment for sixteen days, without proper controlling of the hemorrhage. Once the lung had been immobilized, there was no more bleeding and recovery was remarkably rapid.

Group 6.

Diseases other than phthisis. Treatment may be attempted in bronchiectasis and lung abscess. In other diseases independent of phthisis, Forlanini and Wellman have each treated a case of phthisis that had diabetes mellitus, with satisfactory results as to the lung condition, though the glycosuria remained unchanged.

Group 7.

Incipient Cases. Shall artificial pneumothorax be attempted in the incipient cases?

So far as I know only in advanced and moderately advanced cases has it been used by others. One case of this series is an incipient case. In this instance the results have justified the treatment.

CONCLUSIONS.

The establishing and the maintaining of an artificial pneumothorax is not an indifferent operative procedure but by closely following the technique here described does not present any particular dangers. Nevertheless it is not a treatment for the general practitioner. This method of treatment is not as a rule to be adopted in the early cases neither should it be the only treatment adopted in the serious cases.

The eighteen months' experience I have had in the treating of pulmonary tuberculosis in its different stages have convinced me of its place in the treatment of this disease.

The consensus of opinion among clinicians who have closely watched the effects of Forlanini's method is favorable. In fact, considering that in many cases, as Brauer says, the treatment was a last resort, the results are very encouraging. The method of Forlanini, namely, the production of an artificial pneumothorax in phthisis, aims directly to eliminate from the lung the destructive and tuberculosis process. It has steadily gained ground in the last few years, thanks to the continued work of Forlanini and Brauer. Their faithful labors and gratifying success have induced others all over the world to adopt it.

Any one who has had any experience whatever with present methods of treatment for pulmonary tuberculosis must feel a moral obligation to try every new method that promises any degree of success at all, and it becomes a duty to do so when a method of treatment is presented by which good results have been obtained in advanced cases of phthisis.

It is to be hoped that with the necessary wisdom, the method will be applied on a larger scale and earlier in cases in which the spontaneous evolution shows a progressive and destructive tendency. Phthisiology is not so rich in resources as to justify overlooking a method of treatment that has given such good results.

RÉSUMÉ OF 20 CASES OF PULMONARY TUBERCULOSIS TREATED WITH ARTIFICIAL PNEUMOTHORAX

Case — Beginning of treatment.	Diagnosis.	Sputum.	Remarks.	Results.	Present condition, June, 1912.	Sputum.	Remarks.
1. Josephine A., 29, M. May 5, 1911.	Bilateral. — Moderately advanced—more marked on the left, very slight on the right.	Considerable. Positive.	35 injections. Considerable pain at times. Total amount N. injected, 28,000 c.c.	Amelioration marked from the start. Kept at work. Cough diminishing.	Excellent. — Still under observation. Doing her own work, moved out of town. No tubercle bacilli since Aug., 1911.	None. Guinea pig test negative.	Pneumothorax of left lung. No process in right lung.
2. Vita T., 29, M. May 6, 1911.	Bilateral. — Moderately advanced—more marked on the left.	Considerable. Positive.	6 injections. Considerable pain. Total amount N. injected, 4400 c.c.	Amelioration marked. Very little cough.	Excellent. — Does her own work. Living in Rockland, Me. Gain in weight.	Very little. Repeated examination negative.	Lung has expanded. Recovery.
3. Giuseppe D' A., 30, S. May 5, 1911.	Bilateral. — Advanced — more marked on the right.	Large quantity. Positive.	50 injections. Emphysema once. Occasionally slight pain. Total amount N. injected, 35,000 c.c.	Gradual steady improvement. Steadily at work since Aug., 1911.	Fair. — Works tearing down buildings. Lives in bad hygienic surroundings. Keeps his weight.	Very little in amount. Positive.	Pneumothorax of right lung. Very little activity on the left.
4. Virginia B., 20, S. June 6, 1911.	Unilateral. — Incipient on the right.	Very little. Negative.	12 injections. No untoward symptoms. Total amount N. injected, 10,000 c.c.	Improvement in all symptoms at once. Worked. No injections since Nov., 1911.	Excellent. — Married last Sept., 1911. 8 months pregnant. Living in good hygienic surroundings.	Repeated examination. Negative.	Pneumothorax yet absorbed. Right lung normal.
5. Frank G., 36, M. April 26, 1911.	Bilateral. — Advanced — more marked on the left.	Considerable blood. Positive.	4 injections. Neurotic — considerable pain — difficult patient to control. Total amount N. injected, 2000 c.c.	Symptomatically good. Refused to continue treatment. Entered sanatorium.	Fair. — Very fleshy. Left sanatorium against advice. Has begun to lose weight.	Some. Positive.	Active process in both lungs.
6. Nicholas L., 19, S. April 29, 1911.	Bilateral. — Laryngeal tuberculosis. Advanced — more marked on the left cavity. Pleural adhesions.	Large quantity. Positive.	2 injections. Considerable pain. Emphysema. Total amount injected, 600 c.c.	No change. Throat condition extremely bad.	Died July 15, 1911.		
7. Alphonse R., 42, M. May 12, 1911.	Bilateral. — Advanced — more marked on the left cavity. Pleural adhesion.	Large quantity blood. Positive.	12 injections. Interrupted treatment. Emphysema once. Total amount N. injected, 8000 c.c.	Good in all symptoms, no blood. Continuously at work.	Good. — Gain in weight. Moved out of town. Continues treatment.	Small quantity. Positive.	Difficult to maintain a proper pneumothorax. Very little activity on right.
8. Ciriaco G., 38, M. Oct. 16, 1911.	Bilateral. — Advanced — marked on the left. Pleural adhesions.	Large quantity blood. Positive.	12 injections. Interrupted treatment. Considerable pain. Total amount injected, 6300 c.c.	Symptomatically good. Has continued steadily at work.	Fair. — Works hard. Very little cough.	Some. Positive.	Pneumothorax complete on the left very little activity on the right.
9. Nicholas R., 28, M. Oct. 28, 1911.	Bilateral. — Advanced — more marked on the right. Pleural thickening.	Large quantity. Positive.	15 injections. Untoward symptoms three times. Total amount N. gas injected, 9193 c.c.	Slow, steady improvement in all the symptoms. Worked part of the time.	Good. — Worked part of the time. Gain in weight. Moved to Montreal in March.	Very little. Very few bacilli.	At last examination had a complete pneumothorax of right. Little activity on the left.
10. Fred P., 40, M. Dec. 30, 1911.	Bilateral. — Advanced — active process marked on the left cavity. Pleural adhesions.	Large quantity blood. Positive.	15 injections. Very difficult case to treat — some pain. Total amount injected, 8850 c.c.	Slight improvement in general condition. In a runaway accident. Aggravated condition.	Since runaway accident, loss of weight — weakness, cough aggravated.	Large quantity. Some blood. Positive.	Last examination, process active on the right. Partial pneumothorax on the left.

11. Charles F., 24, S. Jan. 27, 1912.	Bilateral. — Moderately advanced — slight process on the left apex.	Considerable blood. Positive.	23 injections. No untoward symptoms. Total amount N. gas injected, 10,910 c.c. 29 injections. Fainted once. Emphysema twice. Difficult case. Total amount N. injected, 8050 c.c. 5 injections. Slight discomfort. Emphysema. Total quantity N. gas injected, 2580 c.c.	Marked improvement from the beginning. Never lost a day's work while under treatment. Slow steady improvement in all the symptoms. At 23d injection was able to completely collapse lung. No improvement. Unable to take proper nourishment on account of throat condition.	Excellent in every way. Marked gain in weight. Married, June 12th, against advice. Good. — Slight gain in weight — is out doors all the time now.	Very slight in the morning. Very few tubercles. Slight. Positive.	Excellent condition. Process inactive. Moved out of town May 1, 1912. Good — stronger. Complete pneumonia thorax of right, slight active process on the left.
12. Manuel D., 31, S. Feb. 12, 1912.	Bilateral. — Advanced — active process more marked on the right. Pleural adhesions.	Large quantity. Little blood. Positive.	29 injections. Slight discomfort. Emphysema. Total quantity N. gas injected, 8050 c.c.	Immediate improvement. Hemorrhage completely controlled. Bronchitis of right lung one week.	Excellent. — Fever and night sweats, on 7th day normal. Up and about on 15th after 1st injection.	Very little clear. Negative.	Excellent — has complete pneumonia thorax of left lung. No discomfort.
13. Antonette Z., 23, M. Feb. 24, 1912.	Bilateral. — Advanced — active process more marked on the left cavity. Pleural adhesions. Tuberculosis larynx.	Large quantity. Positive.	3 injections. Considerable discomfort. Dextrocardia. Pressure symptoms — temporary irregular pulse. Total quantity N. gas injected, 3250 c.c.	Slow, steady improvement in all the symptoms — slight loss of weight at first, then gain.	Satisfactory. — Able to do some work — goes fishing.	Very little. Positive.	Satisfactory, still continues treatment.
14. Vincent L., 32, M. April 28, 1912.	Unilateral — acute hemoptysis — uncontrolled for 16 days.	Large quantity of blood mixed.	15 injections. Considerable pain 5th, 6th and 10th injection — improvement. Total amount N. gas injected, 5120 c.c.	Slow, steady improvement — slight gain in weight.	Satisfactory. — Brighter and happy looking.	Scanty. Positive. Very few tubercle bacilli.	Satisfactory — improvement continuing. Beginning to attend to work.
15. Edward R., 45, M. May 21, 1912.	Bilateral. — Advanced — active process marked on the left cavity, moderate on the right.	Large quantity. Positive.	14 injections. No untoward symptoms, steady improvement, slight loss of weight. Total amount N. gas injected, 5020 c.c.	Extremely difficult case on account of the pleural adhesions. None.	Moved to the country — unable to continue treatment.	Scanty. Positive.	Recently confined.
16. Vincent B., 43, M. May 22, 1912.	Bilateral. — Advanced — active process more marked on the right cavity. Pleural adhesions moderate on the right.	Small quantity. Positive.	1 injection. Pain, dyspnea — chilliness 6 hrs. afterward. Subsided next day. Total amount N. gas injected, 500 c.c.	Unsatisfactory. — Unable to control any of the symptoms.	Progressive weakness. Died Dec. 12, 1911.	After consultation treatment undertaken as a last hope — progress extremely unfavorable from the start.	Compare amount of nitrogen gas in cases 19 and 20.
17. Eleonora S., 30, M. May 17, 1912.	Bilateral. — Advanced — active process more marked on the right cavity. Pleural adhesions moderate on the right.	Large quantity. Positive.	3 injections. Fever — sweat — extreme prostration — undertaken as a last hope. Total amount N. gas injected, 1500 c.c.	Gastric symptoms have improved.	† Improvement.	Diminished and activity lessened.	
18. Salvatore D., 18, S. Dec. 9, 1911.	Bilateral. — Acute process — hemorrhage from left. Trauma.	Large quantity of blood.	9 injections. No symptoms. Emphysema once. Total amount N. gas injected, 3300 c.c.	Slow but steady improvement.	† Outlook favorable.	Very little.	
19. James F. P., 48, M. May 26, 1912.	Bilateral. — Active process more marked on right cavity. Pleural adhesions. Gastric disturbance.	Large quantity. Positive.	6 injections. No untoward symptoms. Total quantity N. gas injected, 2900 c.c.				
20. Peter W. C., 28, S. June 3, 1912.	Bilateral. — Acute active process marked on the left. Temperature.	Large quantity. Positive.					

• Placed under treatment as a last resort.

† Too early to draw any conclusions.

REPORT OF CASES.

All the following cases except three are ambulatory — in different stages of the disease. The average duration of the disease is about two years.

Cases 1, 2, 3, 5, and 7 are respectively cases 26, 27, 28, 22, and 23 of the Robinson and Floyd series reported in the Archives of Internal Medicine, April 12, 1912. These were patients that I provided from my private clinic and in which I continued the treatment to the present time.

With the exception of Cases 17-19 and 20 they have all been seen at various times during the course of treatment by Dr. Samuel Robinson to whom I am indebted for much help and many suggestions in the preparation of this work.

To Dr. Walter J. Dodd and his associates I am indebted for the x-ray work.

CASE 1. J. A. Female, white, married, 29. Occupation, housework. *Family History.* Father and mother living, three sisters, one brother dead. *Past History.* Six years in U. S. A., 6 years married; 4 children, last one born March 25, 1911. Erythema nodosum last year. *Present Illness.* 10 days' cough, pain in chest, fever, general weakness, headache, "all-gone" feeling, appetite poor, bowels regular. Temperature 102; pulse 120; respiration 30. In bed 3 days, night sweats, cough very troublesome. *Physical Examination.* May 5, 1911. Well developed and nourished. Good size. Poor color. Pupils react. Tongue coated, protruded in median line, teeth good, knee-jerks normal. Tubercle bacilli in sputum. In the right chest above the second rib in front and the spine of the scapula behind there are dullness, bronchovesicular breathing and an occasional fine dry râle. On the left side above the third rib in front and the midscapular region behind there are dullness, bronchial breathing, increased vocal and tactile fremitus and an occasional moist râle. Nitrogen (1000 c.c.) injected in the left anterior axillary line.

May 12. Following the production of the artificial pneumothorax there was a great deal of discomfort, pain and weakness. Had to lie down for 2½ hours. Pulse 120, rather weak, gradually grew stronger and came down to 96. Vomited half an hour after taking morphia. Seen at home, in the night, was comfortable in bed and resting, though complaining of pain and heaviness on left side.

May 14. Up and about; feels better, but complains of pain on the left side. Is taking food well.

May 16. Weight 123 pounds. Examination shows on the right side that there is now only slight dullness at the apex behind. Respiration is harsh throughout the chest. On the left side below the fifth rib back and front there is tympany with diminished respiratory sounds. Above this area there is dullness, bronchial breathing and rare dry râles.

June 3. General condition good. Cough slight. Raises half an ounce in 24 hours. At left base percussion note slightly tympanitic,

respiratory sounds diminished. An occasional dry râle at left apex in front. Patient given injection amounting to 1000 c.c. of nitrogen.

June 21. Feels fairly well. Cough diminished and much drier. Light pains in left chest. Weight $121\frac{1}{2}$ pounds. General condition improved. Examination showed some dullness with diminished voice sounds. No pneumothorax present except small area in upper axilla. No signs on right side. On the left side few scattered râles especially in left front. Patient given an injection of nitrogen gas anteriorly to the amount of 600 c.c.

July 15. Feels well except for slight cough in the morning, raising small amount of frothy sputum. She has been doing her housework and taking care of a family of seven; four children — one is nursing. *Examination.* No pneumothorax evident. Slight dullness and diminished voice sounds and scattered râles in left front. 1000 c.c. nitrogen injected, left anterior axilla. No untoward symptoms.

July 30. Feels well, slight cough. Partial pneumothorax. Injected 800 c.c. nitrogen gas. Pneumothorax complete. Respiratory sounds very faintly audible.

From August 15 to December 10, 1911, patient was seen every two weeks, receiving injections of nitrogen gas, so as to keep pneumothorax complete. At this time repeated examinations of sputum were negative for tubercle bacilli. Weight 125 pounds. Does her own work. Has been working very hard.

January 25, 1912. Patient has been working very hard taking care of a sick baby. Has had to be up many nights. Has developed a bothersome cough, has little appetite and is generally run down. Is suffering now with a severe cold. Has lost weight. The sputum is still negative.

Examination. Left lung has expanded. There are bronchovesicular breathing and râles in the front left from third rib upward. In the back scattered râles throughout. Squeaks are heard throughout right lung with harsh exaggerated respiratory sounds. Temperature 100° . Pulse 96. Respiration 20. Injected 1000 c.c. nitrogen gas without any symptoms.

January 30. Has been much better, cough less irritating. Pneumothorax reaches fourth rib in front. Râles heard at apex. Sputum negative. 1000 c.c. nitrogen injected, thus completing pneumothorax.

March 15. Has been confined to the house since last visit on account of two sick children. Cough very troublesome. Headache and pains all over limbs. Appetite fair. Sputum is still negative for tubercle bacilli. Weight 115 pounds.

For four successive days injected nitrogen gas. Total amount given being 1400 c.c., which was sufficient to immobilize the lung without any discomfort at the time. In the evening I was sent for. The patient was suffering from severe pain on the left side, extending from nipple to shoulder in front and behind. Coughing very painful. Has had to keep very quiet. The pneumothorax was complete, the heart being displaced to the right. There were signs of pressure on right lung. The patient was given $\frac{1}{4}$ grain morphia subcutaneously and put to bed. She passed a comfortable night, but next morning the

pain was quite severe. There was dyspnea and increased pain on exertion. Patient kept to her bed. In the evening another quarter grain morphia given so that she could pass a restful night. Temperature 99.5°, pulse 96, of good quality, and respiration 22. Coughs up a clear sputum. A few squeaks heard in the right lung. The patient kept to her bed for three days more, getting better and not needing any morphia. At this time her sister-in-law came to live with her, and has taken care of most of the work.

April 1. Feels much better. Coughs very little and what sputum she raises is clear and frothy. Right lung is clear and there are no longer squeaks. Left lung tympanitic throughout, no râles, but respiratory sound is heard at apex. 100 c.c. nitrogen gas injected.

April 22. Is feeling better, hardly any cough. Sputum sent to be inoculated into guinea pig. Pneumothorax apparently complete. 100 c.c. nitrogen gas introduced. No pain. I have urged this patient to move away from the North End and she has promised to do so the first of May.

May 1. Patient has moved to Chelsea. Appears well contented. Does not work so hard. Pneumothorax of left lung still complete. Pulse 72, of good quality. No signs on the right.

May 15 to June 2. Condition unchanged. No cough or expectoration. General condition good. Weight 120 pounds.

June 3. Report from the sputum sent to be inoculated into guinea pigs March 22, 1912. "Guinea pigs inoculated. 4-23-12, Autopsied, 6-3-12. No lesions and no tubercle bacilli found."

June 11. Patient shown to the Section on Tuberculosis of the Massachusetts Medical Society.

June 16. Continues to feel well. Introduced 200 c.c. nitrogen gas to complete pneumothorax.

Nothing abnormal heard in right lung.

July 6. Weight 124½ pounds, feels fine, has no cough, no sputum; is doing her own housework. General condition very satisfactory.

REMARKS

This patient represents a class of cases frequently met with. Large family and plenty of work. It must be noted that she has lived in unfavorable hygienic surroundings, has had considerable sickness in her family, causing increased work and worry. She left off treatment for a while, which caused the old symptoms to return, but note that repeated sputum examinations showed the absence of tubercle bacilli. Then note also the marked improvement once the pneumothorax was established and maintained.

CASE 2. V. T. Female, 29, white, married. Family History. Mother died in confinement. Sisters and brothers well. *Past History.* Married 8 years. 3 children, miscarried at the third month, 1 month ago. *Present Illness.* Three months pain in chest, cough, night sweats. Appetite poor. Bowels regular. Great deal of sputum. No blood noticed in it. *Physical Examination.* May 6, 1911. Well developed and fairly well nourished. Fair color. Tongue clean, protruded in median line. Teeth good. Pupils react. Weight 123

pounds. Tubercle bacilli in sputum. On the right side above the second rib in front and the spine of the scapula behind dullness, increased resistance, vocal fremitus, increased bronchial breathing, an occasional dry râle. On the left side there are signs of consolidation above the fourth rib in front and the angle of the scapula behind. Over this area are numerous moist râles, both coarse and fine. By means of thoracentesis in the eighth space anterior axillary line 500 c.c. of nitrogen were injected without discomfort to the patient.

May 12. No night sweats. Feels heavy on injected side; weight 123½ pounds. Examination shows that the signs of consolidation at the right apex are less marked. Dullness less intense, breathing less bronchial. On the left side there is an area of tympany at the extreme left base. Above this area signs of pulmonary infection remain unchanged. Patient reinjected in the eighth intercostal space in the posterior axillary line, 900 c.c. of nitrogen gas being introduced.

May 16. No night sweats; sputum temporarily increased following last inoculation. General condition improved; weight 123½ pounds. Examination shows right apical signs to be slight. On the left side tympany extends up to the level of the fifth rib behind. Over this area fremitus and respiration sounds are much diminished. No râles are present over the area of consolidation at the left apex. Heart is somewhat displaced toward the right side.

June 21. Very little cough. No expectoration. Examination shows very little activity in chest. Occasional scattered râle in chest on left side. No pneumothorax present. Thoracentesis is given in anterior axillary line and 600 c.c. of nitrogen gas injected.

There was a great deal of pain during the introduction of the nitrogen and for two hours afterwards.

June 23. Weight 125 pounds. Cough slight, no expectoration; looks and feels well. Examination shows pneumothorax has been absorbed. At the extreme left apex, signs of consolidation persist, rare dry râle heard. Patient was given another injection of 700 c.c. of nitrogen.

June 30. Slight cough in the morning; very little sputum. Examination shows occasional scattered râles on the right; breathing is markedly increased. On the left fine crepitant râles on apex. There is tympany throughout anterior part of left chest with diminished respiratory sounds.

Injected 900 c.c. nitrogen gas in midaxillary line. Very little pain felt. After resting fifteen minutes patient went home.

July 3, 1911. "Feeling fine;" does not cough or raise any sputum. For the last three days has been out in the country. I have advised her to move to the country.

On examination the left lung throughout the anterior part is tympanic. Feeble respiratory sounds. No râles heard except an occasional one at the apex.

Tympany less marked in the back and respiratory sounds plainly audible. Injected 800 c.c. nitrogen gas. This apparently completed pneumothorax. No râles heard in any part of left lung — coin sound demonstrable.

The right lung is hyperresonant; respiration loud and harsh in

character. Very little pain felt after the injection. Heart, which is displaced about two fingers' breadth to the right, has a regular rate of 100.

July 10. Has been in Woburn for the last week. General condition good, except for shortness of breath on exertion. Weight 128 pounds. Appetite increasing. Pneumothorax is still complete on the left. No râles heard in any part of chest. Heart still displaced, condition good. No cough. No expectoration. Patient is going to Rockland, Maine.

March 30. Since she has been away she has sent the sputum three times and each time it has been found negative for tubercle bacilli. At present her weight is 132 pounds. Has no cough, occasionally a little sputum in the morning.

On examination the lung has completely expanded, no râles heard anywhere; there is bronchovesicular breathing at left apex in front and rather harsh breathing behind. Lung is mobile throughout.

X-ray by Dr. Dodd shows a completely expanded lung.

Sputum examination is negative.

June 9. Patient wrote that she was feeling well, had no cough to speak of, did all her own housework and was about to be confined. She sent a small bottle containing a little sputum which was found negative.

REMARKS.

On account of the pain this patient suffered during and after some of the injection she often threatened to leave off treatment. She was persuaded to continue on account of the improvement. Steady gain in weight and disappearance of symptoms certainly were due to the treatment.

CASE 3. G. D'A. Male, 30, white, single. Occupation, laborer. *Family History.* Father and mother living and well. Two brothers, 3 sisters well. *Past History.* Pleurisy 8 years ago while a soldier in Italian army. Seven years in U. S. A. One year ago began to cough and has had this cough off and on ever since. At the beginning of cough spat blood for two days, none since. *Present Illness.* Two weeks now feels run down, cough, night sweats, cough bothers him worse at night. Pain on coughing in the region of the midsternum. *Physical Examination.* May 5, 1911. Well developed and nourished. Good color. Pupils react. Tongue clean. Weight 148 pounds. In the left chest, above the first rib in front and the spine of the scapula behind, there are dullness, bronchovesicular breathing, increased vocal fremitus. On the right, above the third rib in front and the seventh rib behind, there are dullness, bronchial breathing, increased vocal and tactile fremitus, numerous medium and coarse moist râles. At the extreme right base respiration is limited. Tubercle bacilli in sputum.

May 12, 1911. Artificial pneumothorax performed. Anterior axillary line, level of the fourth rib of the point of injection and 400 c.c. of nitrogen gas introduced. At end of introduction of gas patient had fainting sensation, but soon recovered and was able to dress and leave.

May 14. Cough less, raises less sputum, does not have any night sweats. Pain at site of puncture on coughing. Feels better to-day.

May 16. Examination shows, on the left side, area of dullness much diminished and respiratory sounds normal. On the right side above first rib in front and fourth rib behind, dullness, bronchovesicular breathing, and no râles are heard. Below the level of the fifth rib in front and the angle of scapula behind there is a tympanitic note on percussion, with diminished respiratory sounds.

June 6. Examination shows persistence of pneumothorax at the right base. Some slight expansion of lung with a reappearance of a few râles in right front. Patient given a second injection of 1200 c.c. of nitrogen which was well endured, no cardiac displacement.

From July 15, 1911, treatment has been carried on by the author alone.

Physical Examination. July 15. Right Lung. Pneumothorax to sixth intercostal space in front. Respiratory sounds feeble, few râles at apex. *Left lung.* Dullness above first rib in front and behind the scapula. Increased fremitus, moist, coarse râles. *Tubercle bacilli* in sputum.

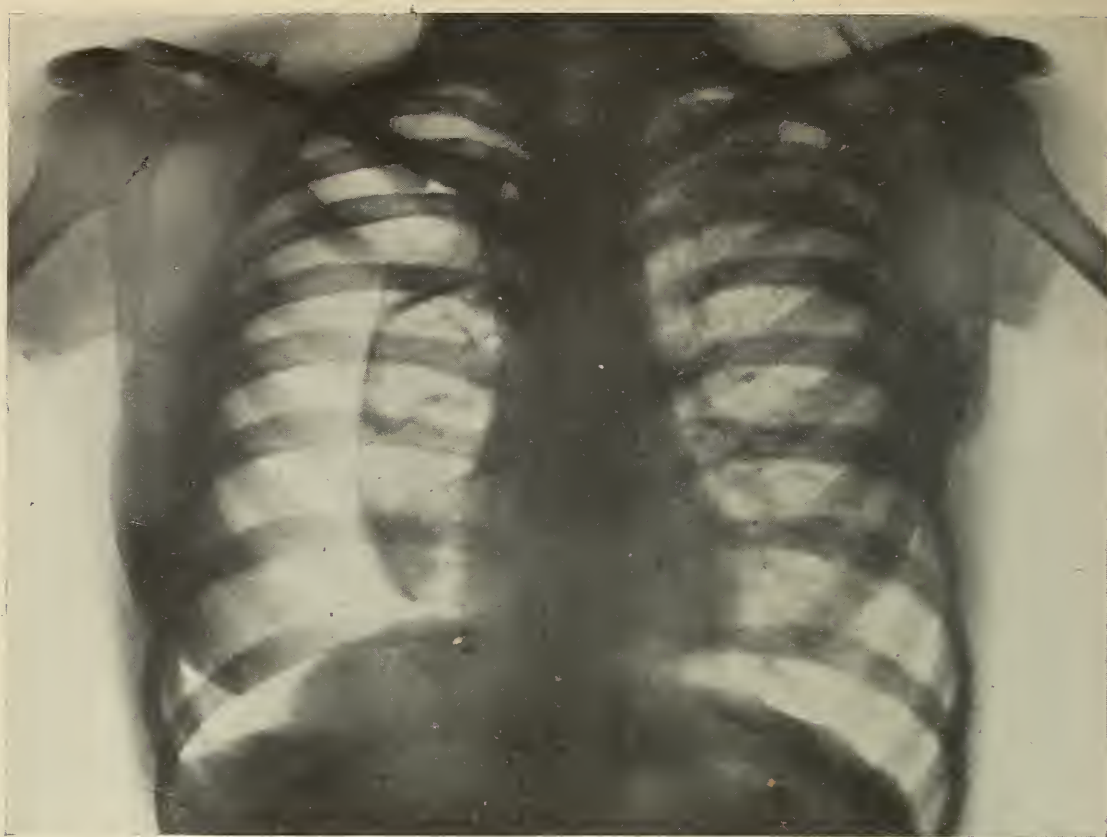
Feels much better, cough is less, not troublesome at night, no night sweats. Is working. Patient given injection of 1000 c.c. of nitrogen. Felt perfectly well after injection.

July 22. Feels better, sputum is less. Partial pneumothorax, 1000 c.c. nitrogen gas injected. Pneumothorax now complete.

July 30 to June 1, 1912. Patient has been steadily at work, part of the time indoors and part of the time outside, tearing down old buildings. He has come for treatment twice a month. It was always necessary to inject nitrogen gas as the pneumothorax was partially absorbed. It was impossible to make him change his work to an exclusive out-of-door life. Nevertheless he has coughed very little, the sputum has been small in amount; repeated examinations show tubercle bacilli still present. He lives in the North End in poor hygienic surroundings. With all these disadvantages the patient has been able to work and there has been marked symptomatic relief.

CASE 4. Virginia B. 20, single. May 10, 1911. Works in Woolen Mill, Plymouth, Mass. *Family History.* Negative. *Past History.* One year ago was ill three weeks with pneumonia. *Present Illness.* Five months ago began to complain of slight pains in right side of chest, slight cough, slight expectoration. Diminishing appetite, slight nausea, bowels regular, menstruation regular. Two months ago began to have night sweats and chilly sensations with slight evening rise of temperature; cough persists; little sputum, which is negative. Some loss of weight. *Physical Examination.* May 15, 1911. Well developed and fairly nourished. Mouth and teeth in good condition. No glandular enlargement. Chest symmetrical and well proportioned. On the right above second rib in front dullness, bronchovesicular breathing with crepitant râles. Behind above spine of right scapula dullness with bronchial breathing. Left lung, negative. Heart, negative.

June 6. 700 c.c. nitrogen gas injected going into fifth interspace



CASE IV. Incomplete pneumothorax, right side; no evidence of adhesions. Complete pneumothorax obtained in this case after injection of greater quantity of nitrogen gas. Very slight process in left lung that is inactive. This patient has absolutely no symptoms and is enjoying perfect health.



CASE VIII. Incomplete pneumothorax, left side; adhesions in upper part of chest prevent complete pneumothorax. Extensive process in right lung. Old bilateral process. Marked symptomatic relief. While under treatment

about one inch inside midaxillary line. The patient had absolutely no symptoms. She immediately came off the operating table and dressed. Pulse of good quality, 78.

June 14. Feels a little better. Tympany throughout the front lung with diminished breathing. Fine dry râles at apex. 1000 c.c. nitrogen gas injected. Except for a slight feeling of tightness about the chest no discomfort whatever. The respiratory sounds are very faint. No râles heard. In noncompressed lung exaggerated and harsh respiratory sounds. Heart condition good.

June 22. Has been coughing very little, no sputum whatever. No longer has night sweats. The appetite is good and the general condition of the patient has markedly improved. 500 c.c. nitrogen gas injected. No symptoms. The patient came regularly every two weeks for treatment. She felt so well that she married. After that she came every month up to November. She received altogether eleven injections of nitrogen gas, totaling 9200 c.c. Since November she has received none, as the pneumothorax was complete. Her last injection was given in November, when an x-ray taken by Dr. Walter J. Dodd showed a complete collapse of the lung.

I have been in communication with the patient right along. She has continued in good condition. In April, 1912, she came again for examination. The pneumothorax was still complete. An x-ray taken showed the lung still collapsed but not as much as it was in November when the first x-ray was taken.

June 11. She was shown to the Section on Tuberculosis of the Massachusetts Medical Society. General condition was excellent. No cough or sputum. There was a gain in weight and she was seven months pregnant.

REMARKS

This is the only incipient case of the series. In the literature there is no report of any incipient cases treated. The refusal on the part of the patient to enter a sanatorium and the depressed mental and physical condition to my mind justified the treatment before there was a further progress in the disease. She has remained in perfect health. She has been doing all her own housework. This case illustrates a point which is very marked as you study this series of cases. Where the lung is little involved, as in an early case, the pneumothorax is maintained complete longest without replenishing. The more extensive the lesions, the more often are replenishments of nitrogen gas necessary, for the gas is absorbed more quickly.

CASE 5. F. G., male, 36, white, married. Occupation, machinist. *Family History.* Father and mother living. Six brothers and 4 sisters well. *Past History.* Negative. Denies venereal disease. Five years married. Two children. Wife well. *Present Illness.* Three months ago began to feel run down; cough, weakness; no blood in sputum. April 20, 1911. Took to bed and was in bed 12 days with pneumonia; had night sweats, cough, fever, pain in side. *Physical Examination.* Fairly well developed and nourished. Thin; tongue clean, teeth good, pupils react and are equal, knee-jerks, chest flat, depression below

clavicle. On left side above midscapula behind and third rib in front there are dullness, bronchial breathing, increased vocal and tactile fremitus and numerous dry râles. On the right side above second rib front and the spine of the scapula behind there are dullness, bronchial breathing, increased fremitus both tactile and vocal and an occasional râle. Nitrogen injected by the Forlanini method in the anterior axillary line on the left side; 400 c.c. introduced without discomfort.

May 16. Cough less, expectoration slight. Weight 117 pounds. On left above midscapula behind and third rib in front dullness, bronchial breathing. Increased vocal and tactile fremitus, occasional dry râles. Below dull area there is moderate tympany upon percussion, diminished fremitus and respiratory sounds. On right above second rib front and spine of scapula behind signs as on left.

June 6. Patient at present has no symptoms. Feels better. Examination shows signs of consolidation on the right side much less marked. On the left side there is evidence of lung compression with an area of tympany over the lower lobe. A few dry râles persist in the area of consolidation. By means of thoracentesis patient was given 800 c.c. of nitrogen gas. Injection was given in anterior axillary line. There were no symptoms following the production of pneumothorax.

June 21. Working and feeling well. No cough.

REMARKS.

A complete pneumothorax was never produced in this case. As soon as the patient had obtained symptomatic relief he refused to continue treatment. The patient became careless, travelling from one place to another. His friends becoming tired of helping him, he was finally induced to enter a sanatorium where he remained for about ten months, leaving against advice, with a still active process. When seen recently he had begun to lose weight, the cough was troublesome and there was a beginning throat lesion.

CASE 6. N. L., male, 19; white, single. Providence, R. I. *Family History.* Father died of pneumonia last year, 1 brother died as result of an accident, 2 brothers died in infancy. *Past History.* At 9 years of age had pain in left side which was very severe at first. *Present Illness.* Fourteen months ago general weakness, cough, fever, night sweats, blood in sputum; gradually losing weight. For the last two months considerable pain on deglutition. Tubercle bacilli in sputum. *Physical Examination.* April 29, 1911. Fairly well developed and nourished. Thin, skin dry and hot, tongue clean, teeth good, pupils react, weight 90 pounds. Examination shows both apices involved, more marked on left side. Signs of consolidation above second rib on right and fourth on left. Râles few and fairly dry. Some dullness at extreme left base. Tuberculous ulceration of the larynx.

Injection made by Forlanini method in anterior axillary line, 300 c.c. nitrogen being introduced and then operation stopped on account of pain. Nitrogen flowed slowly and with difficulty but under little pressure. A small pleural sack probably surrounded by adhesions distended by nitrogen, no pneumothorax demonstrable.

May 7. Following the injection on April 29th, he felt much better. The throat condition bothered him making it very difficult for him to swallow.

Injected 300 c.c. nitrogen gas into the fifth interspace midaxillary line. There was considerable pain for an hour after the injection. The general condition of the patient did not warrant travelling the long distance he came for treatment and he was advised to discontinue it.

Died July 15, 1911.

CASE 7. A. R., Male, 42. June 21, 1911. A bilateral case with slight activity in the right lung, and extensive involvement of the left lung with cavity formation at third interspace in front. Before commencing treatment an x-ray was taken by Dr. Walter J. Dodd.

April 12, 1912. Patient has not received any injection of nitrogen gas since June 21, 1911. The last injection caused some constriction about the throat and a slight subcutaneous emphysema, which troubled him a few days. I have seen this patient almost daily since. He has kept in fairly good condition, as his work has kept him out of doors. 1000 c.c. nitrogen gas introduced, into fifth space an inch inside left midaxillary line, without any discomfort whatever, the gas entering for the most part anteriorly and not displacing the heart.

April 19. 1800 c.c. nitrogen gas introduced with absolutely no discomfort. On account of the pleural thickening the needle went very deep. This amount of gas did not cause any heart displacement. At the beginning of the introduction the apex beat was seen plainly outside and below the nipple line. At the end it had not perceptibly altered its position, so we conclude that the heart must be bound down by adhesions. This amount obliterated the râles from the left lung, though the signs of the cavity were still evident. Soon after this injection there was marked improvement in the general condition of the patient. During the week the cough became looser and less troublesome, the night sweats disappeared, and the appetite improved.

April 28. Crepitant râles at left apex, bronchovesicular breathing and signs of a cavity. Exaggerated respiratory sounds harsh in character. Dry and musical râles from second rib in front and from spine of scapula behind. Feels very well and is working. 1200 c.c. nitrogen gas introduced with no pain or discomfort. This amount did not obliterate all the abnormal sounds.

May 7. Has gained three pounds while under treatment. Has had pleuritic pains in right chest. Some cough, but looser. 1800 c.c. nitrogen gas injected, which obliterated the râles but not the signs of cavity at the third rib.

May 14 to May 31. Continues to improve; has come regularly every week for replenishment.

June 11. Shown to the Section on Tuberculosis of the Massachusetts Medical Society.

REMARKS.

A very difficult case to control. The nitrogen gas is very rapidly absorbed, because of the great amount of work the patient does and

the advanced stage of the process in the lungs. There has been no return of the hemorrhages which he had last year. On two occasions I have injected 1800 c.c. nitrogen gas without displacing the heart or causing any symptoms whatever. The manometer also showed very little increase in the positive pressure. The process in the right lung is at a standstill. After each injection there is always an increased amount of sputum which is still positive. The patient is still at work.

CASE 8. C. G., 38, married. Grocer. October 16, 1911. Referred by Dr. R. P. Bonnelly. *Family History*. Negative. *Past History*. Eight years ago operated upon for appendicitis. Has had pulmonary tuberculosis for six years, and four years ago was in the State Infirmary. Cough, large amount of expectoration, pains throughout the chest, dyspnea on exertion, chilliness, occasional night sweats. *Physical Examination*. Worried looking man, appears to have suffered a great deal. (He has a family of five to support by keeping a little grocery store.) Weight 121 pounds. Extensive involvement of left lung, with a small cavity between second and third rib. Moist and crepitant râles throughout lung front and back. Right lung moderately involved at apex. Large quantities of tubercle bacilli in sputum.

Introduced 100 c.c. nitrogen gas into the left pleura, going in the sixth interspace midaxillary line. The intrathoracic pressure was not changed, remaining negative at end of the introduction. Patient had considerable pain, necessitating hypodermic injection of $\frac{1}{4}$ grain morphia. Patient was kept quiet for an hour.

October 20. Patient was uncomfortable the whole of the next day after the injection. 200 c.c. nitrogen gas was introduced. There was much pain, some troublesome cough soon after. The pulse became rapid and weak. Patient kept absolutely quiet for one and a half hours, at the end of which time he felt better. The gas went mostly anteriorly, displacing the heart somewhat to the right.

October 27. 500 c.c. nitrogen gas introduced in the sixth intercostal space below angle of scapula. Very little pain. The intrathoracic pressure at end of the introduction positive, 4 cm. water.

November 8. Pains across chest gone, cough is less, but sputum is increased and easier to raise. 500 c.c. nitrogen gas introduced. Patient felt a sharp pain back of the left shoulder for a few minutes after introduction. Heart pushed to the right, pulse rate 90, but of good quality. There is tympany throughout the left front chest, faint respiratory sounds in front, more marked behind above angle of scapula.

At third rib amphoric breathing. Right lung, respiratory sounds, exaggerated and of a harsh quality. Dullness to percussion less evident. Few râles heard.

November 11. About the same. 500 c.c. nitrogen gas introduced.

November 15. Feels better, cough persists, but expectoration is easy. 600 c.c. nitrogen gas injected into fifth interspace midaxillary line. A feeling of tension throughout left chest, some discomfort in the stomach. Heart action good. Pulse 84.

November 28. The evening following the last injection was very

uncomfortable on account of discomfort in the stomach and pain in left side. Had to stay in bed all the next day. There have been no night sweats but cough and sputum about the same. 650 c.c. nitrogen gas introduced. Intrathoracic pressure 10 cm. water. Pneumothorax complete. Absence of amphoric breathing between second and third rib. No râles heard in left lung. Heart displaced 2 cm. to the right; action good, rate 86. Chest feels tense.

January 15. Has been pretty well. Has had to work hard and has been up several nights with a sick son. For the last ten days has coughed a good deal. On examination, pneumothorax reaches fourth rib in front. There is a return of amphoric breathing and râles in front and back. The lung has reexpanded. Patient has lost two pounds. Introduced 700 c.c. nitrogen gas. He felt better after the introduction. Râles wholly obliterated.

February 7. Cough has been less and there has been no return of pains in the chest. 1000 c.c. nitrogen gas required to complete pneumothorax. No discomfort except for a little dyspnea.

February 14. Has been working hard. Appetite rather poor. Cough about the same. 600 c.c. nitrogen gas introduced.

March 19. Much better and has gained one pound in weight. Amphoric breathing at third interspace and dry râles persist at the left apex. 700 c.c. nitrogen gas injected. Little dyspnea and slight pain. Pulse rate 84 and of good quality. Process in right lung apparently inactive.

April 15. Does not feel as strong as usual. Has been very irritable on account of business loss. He coughs less and raises much less. 200 c.c. nitrogen gas introduced. Very little discomfort.

May 1 to May 23. Condition remained unchanged.

May 30. Feeling better, still coughs in the morning, sputum is readily expelled. On examination there is tympany throughout left chest with diminished respiration. Few dry râles at apex. Occasional moist râles at right apex. 800 c.c. nitrogen gas injected — very little discomfort felt. X-ray taken soon after showed lung to be completely collapsed.

June 4 to June 30. Condition unchanged. Attends to his business as usual. Weighs 119 pounds now. Coughs only in the morning. There are tubercle bacilli in sputum.

REMARKS.

There has been symptomatic relief; the pains in the chest have gone, the cough and sputum are markedly diminished. He has kept continually at work. His best weight, 121 pounds, has not been regained yet, the present weight being 119 pounds. He has received marked benefit from the treatment. He has not been able to come as often as he should on account of living too far away. And it has been impossible to maintain the pneumothorax complete for any length of time.

CASE 9. N. R., 28, male, married. October 28, 1911. Works indoors. Cambridge, Mass. *Family History.* Negative. *Past History.* Three years ago pleurisy with effusion, which was not aspirated.

Present Illness. For the past nine months has had a cough, pain in the chest, night sweats, gradual increasing weakness and poor appetite. Raises considerable sputum, has been married two months. *Physical Examination.* Well developed and fairly nourished, somewhat emaciated, pale color. Weight 123 pounds. Teeth, tongue and mouth normal. *Right Lung.* Dullness, increased fremitus and bronchovesicular breathing above third rib in front and angle of scapula behind. Moist râles at apex, crepitant and fine râles scattered over the back. *Left Lung.* Dullness and râles at apex. X-ray examination by Dr. Walter J. Dodd. (*See Illustration.*)

November 5. 90 c.c. nitrogen gas injected into right pleural cavity, going into the fifth intercostal space in front. A solution of $\frac{1}{2}$ per cent of cocaine was used as a local anesthetic. After the introduction patient had a fainting sensation and headache. These symptoms passed off in about ten minutes. Meanwhile the patient was kept quiet, lying on the operating table.

November 9. Has been up and about as usual. 200 c.c. nitrogen gas introduced. Slight discomfort. A cold sweat came over the patient, but fifteen minutes afterwards felt well.

November 14. Has kept at work in pork factory. I have advised him to stop work for a while. The cough has been troublesome and he has had pains across chest. 100 c.c. nitrogen gas introduced.

November 20. Is not working now. Feels a little better. 500 c.c. nitrogen gas injected. Very little discomfort felt.

November 28. Has been about the city most of the day and is rather tired. I prepared patient for introduction of nitrogen gas. After injecting the cocaine the patient became pale, and was faint, and vomited, so I did not give the injection of nitrogen gas. On inquiry it was found that he had not eaten for ten hours, when he had partaken of a light lunch.

December 5. Patient is not working. On examination the pneumothorax was found to extend to the sixth rib anteriorly. Respiratory sounds heard throughout lung. Crepitant and fine râles above fourth rib in front. Condition of the patient not satisfactory. 500 c.c. nitrogen gas injected in sixth interspace midaxillary line on the right. No untoward symptoms.

December 12. Patient feels a little better. Coughs less. 700 c.c. nitrogen gas injected. Except for a few râles at right apex no abnormal sounds are heard in the right lung. The pneumothorax is well marked throughout. The left lung shows increased function. There are some crepitant fine râles at apex. Heart is not displaced.

December 20. Feels better, and cough has diminished. 750 c.c. nitrogen injected. No untoward symptoms.

January 2. 1000 c.c. nitrogen gas injected. No untoward symptoms.

January 15. Patient has been feeling well. Cough bothers him very little. Stays out of doors most of the time. Weight has increased four pounds. 2000 c.c. nitrogen gas injected, producing very little discomfort. Felt little pain across midsternum. This practically immobilized the whole right lung. No râles heard in any portion of the lung. Condition of heart good.



CASE IX. Extensive tuberculous process involving both lungs; more marked in right than in left lung. Abscess cavity in left apex; also one in right lung, second interspace near axillary border. Type of bilateral case that has done remarkably well under treatment. The last two sputa examinations showed a rare tubercle bacillus.



CASE XI. Plate shows extensive tubercular process involving whole of right lung. Process more marked in upper portion of lung. Left lung normal. At present time has absolutely no symptoms, attending daily to his business and enjoying good health. Unilateral case, the type that gives the best results with pneumothorax therapy.

January 30. After the last injection was a whole day in bed on account of pain across chest and in back of shoulder. Feels much improved, however. Very little sputum raised and that only in the morning.

Very few râles heard at apex and in upper half of right back. Lung has expanded — respiratory sounds heard throughout. 1700 c.c. nitrogen gas injected. Pneumothorax complete. No discomfort.

February 15. Patient is doing well. 500 c.c. nitrogen gas injected.

February 29. Has gained two pounds in weight. General condition is good. 500 c.c. nitrogen gas injected.

March 7. 100 c.c. nitrogen gas introduced. No râles heard in any part of right lung. Condition of left lung good.

March 23. Patient has been working since the last injection. Has some shortness of breath on exertion. Otherwise feels well. 500 c.c. nitrogen gas injected. No discomfort.

March 30. Patient feeling in fine condition and has good color. There are no night sweats. Very little cough. Walks a great deal without discomfort. 100 c.c. nitrogen gas injected.

REMARKS.

This has been one of the most difficult cases to handle. As long as cocaine was used as a local anesthetic, the patient presented symptoms of cocaine poisoning. When novocaine was used instead there were no such symptoms. As soon as patient stopped work the condition began to improve. Also, notice the large quantities of nitrogen injected at a time and the rapidity of absorption. Physical exertion favors the rapid absorption of nitrogen. Considering the advanced process on the right, the considerable process in the left lung and the home condition of the patient the treatment has shown its value.

The need of frequent systematic introduction of nitrogen gas is self evident. This patient would have had a much more rapid improvement if he had come oftener so as to keep the pneumothorax under better control. After the last insufflation he moved to Montreal. He then was in splendid condition. The pneumothorax was complete in the right lung. The sputum examination showed the presence of very few tubercle bacilli.

CASE 10. F. P., 40, married. Grocer. December 30, 1911. *Family History.* Negative. *Past History.* Negative. *Present Illness.* Three years ago began to cough and there was blood in the sputum for two months. Has been to California and the Azores for the cough without obtaining any benefit. Cough is so troublesome at night that it interferes a great deal with rest. Raises large quantity of sputum. Has had several hemorrhages and has night sweats. *Physical Examination.* Weight 147 pounds. Well developed and fairly nourished, poor color. Mouth is in good condition and teeth fair. Temperature 98.9°, pulse 80, respiration 20. *Right Lung.* Dullness, bronchial breathing and increased fremitus in upper third. Moist râles scattered over this area but more marked from second rib to apex. *Left Lung.* Extensive disseminated foci throughout with a large

cavity between third and fifth rib. X-ray taken before beginning treatment.

January 11. 150 c.c. injection gas injected into left pleura going into the sixth interspace in midaxillary line. Little pain felt. Kept quiet twenty minutes after the injection. Pulse remained good throughout.

January 16. 450 c.c. nitrogen gas injected in the same space. No untoward symptoms. The next day had a good deal of pain; after that felt as usual.

January 24. There has been no change in the general condition. 850 c.c. nitrogen gas injected. Felt some pain across the chest and back of left shoulder that persisted until the next day.

January 27. 1000 c.c. nitrogen injected. No untoward symptoms. The cough is more troublesome and raising sputum is a little easier. Most of the gas is in front. The left chest anteriorly is tympanic, respiratory sounds and râles are diminished. Amphoric breathing persists between third and fifth rib. Moist râles clearly heard at apex. Right lung still shows signs of consolidation. A few moist râles at apex. Dry and musical râles in upper third in front. Respiratory sounds increased throughout. 1000 c.c. nitrogen injected. Slight pain in cardiac area and heavy sensation below costal margin. The heart is displaced to the right, but is working normally and rate is 84. That evening and for the next two days was not able to eat as much as usual on account of the stomach feeling full. He had a severe fit of coughing which caused him to throw up his supper, but otherwise has been well.

February 3. Pneumothorax is partially absorbed as is evident by the reëxpansion of the lung. 1000 c.c. nitrogen gas injected. Amphoric breathing still made out between third and fifth rib and râles are heard at apex.

February 29. Has slept better and has coughed less, but raises more sputum since last injection. Appetite has been good. Weight now 149½ pounds. Examination shows lung has considerably expanded since last injection. 2000 c.c. nitrogen injected with absolutely no discomfort. Heart displaced to the right.

March 12. Has been feeling well and the cough is less troublesome. Pneumothorax is partially absorbed. 600 c.c. nitrogen gas injected. No untoward symptoms. Dry râles heard over the area of consolidation in right lung.

March 19. About the same. 800 c.c. nitrogen gas injected.

March 26. Has been quite active attending to business. The cough has bothered him more but the amount of sputum is the same. Lung has expanded considerably. 600 c.c. nitrogen gas injected, apparently completing the pneumothorax. The manometer reading shows the intrathoracic pressure to be higher during inspiration. Feels perfectly well.

April 2. 800 c.c. nitrogen gas was injected in the sixth interspace below angle of scapula on the left. Some pain referred to the front. Manometer shows intrathoracic pressure to be 8 cm. water.

April 10. When patient was going home after the last injection,

got a fearful shaking up in a runaway accident. That night he was very sick, spat up some blood and was unable to take much nourishment for two days. Has not been as well since.

There is considerable expansion of left lung, as is evident by the increased respiratory area and the râles. 1000 c.c. nitrogen gas introduced in sixth interspace in the back.

April 17. Cough has been rather troublesome with some pain across the chest. The appetite has not been good. 400 c.c. nitrogen gas injected. Except for amphoric breathing between third and fourth rib and some râles at apex, no abnormal sounds. Has some pain in region of stomach and a heavy sensation in left hypochondrium.

April 24 to May 27. The patient has come every Monday for examination and replenishment. The pain in the stomach and heavy sensation have disappeared. He has coughed about as much as usual, but no more blood has appeared. Has not had any night sweats.

REMARKS.

Advanced bilateral cases like this seem to absorb the nitrogen gas very rapidly and it is very difficult in office practice to maintain the pneumothorax to its proper volume and pressure and one has to be satisfied with only partial results. There is no doubt that the patient has received considerable benefit as is evident by the increased weight, absence of night sweats, a more cheerful disposition, and the diminished activity of the process in the right lung. The upset on account of the ride, April 10, undoubtedly is responsible for the present discomfort and slight retrogression. Examination of the sputum at varying intervals has always shown tubercle bacilli. Never any temperature when patient presented himself for the treatment.

CASE 11. C. F., 24, male, single. Lives in the North End, Boston, Mass. *Family History.* Father died of tuberculosis. *Past History.* Always well up to six months ago when he began to spit blood for two days; as he did not get any worse and blood stopped, he paid no attention to it and kept at his work. *Present Illness.* Three days ago spat up some blood. Has a slight cough, raising a little sputum. General feeling of weakness, sleeps poorly and has night sweats. Appetite poor, bowels regular. *Physical Examination.* Well developed and fairly nourished. Teeth and mouth in good condition. Evident loss of weight. Weight $130\frac{1}{2}$ pounds. *Right Chest.* Dullness, increased fremitus, bronchovesicular breathing and moist râles above third rib in front and the angle of scapula behind. Scattered crepitant râles in middle lobe. *Left Chest.* Bronchovesicular breathing and a few râles at apex. Heart apparently normal.

January 27. X-ray taken by Dr. Walter J. Dodd, (see illustration) shows extensive disease of right lung, more marked in upper lobe. Left lung shows little evidence of involvement.

January 29. 50 c.c. nitrogen gas were injected into right pleural cavity, going into the fifth interspace on outer side of nipple line. The patient was extremely nervous but there were no untoward symptoms. The pulse was rapid, rate 110.

January 31. Except for a little soreness at site of injection, patient feels the same. 500 c.c. nitrogen injected as before. Felt perfectly well. Pulse rate 96. Gas is mostly in the front of the chest.

February 5. Patient has raised more sputum than usual; feels well. 500 c.c. injected in same space. There is tympany all over the anterior part of right lung, diminished respiratory sounds. Râles still heard above second rib.

February 8. Has been sleeping and eating better. Cough does not bother him much, except a little in the morning. Has gained four pounds in weight. Looks more cheerful. 500 c.c. nitrogen gas injected. A little subcutaneous emphysema developed about pectoral muscle. A feeling of constriction about neck, and a feeling of tension about chest. Nasal voice. The gas was introduced at high pressure, as it was flowing in very slowly. The manometer at end of introduction shows the intrathoracic pressure to be 10 cm. Shooting sharp pains across the right chest radiating to shoulder. Except for a few râles at right apex, the lung is practically immobilized. Patient passed an uncomfortable night due to the tension in chest and constriction about throat. Slight pain at site of injection.

February 13. Feels well, has no pain, very little sputum raised. Râles heard at apex, respiratory sounds feeble throughout right lung. When 200 c.c. nitrogen was introduced, patient complained of tightness about chest. The flow of gas was stopped. On examination the pneumothorax was found to be complete for no râles were heard anywhere and respiratory sounds were indistinct.

February 27. Weight 138 pounds. "Feeling fine." Pneumothorax is still complete. Introductions of nitrogen gas have been made weekly up to the present time, the amount varying from 200 to 1600 c.c. The patient has progressively gained in weight and strength. In fact, he has never been so fleshy.

March 1 to June 10. Patient has come steadily for replenishments of nitrogen gas. He has steadily improved. On this last date Dr. Samuel Robinson examined him and injected 1500 c.c. nitrogen gas. The general condition is excellent. Weight 150 pounds.

June 12. Married against advice.

July 1. The right lung has completely expanded. A few râles heard at apex. Introduced 1500 c.c. nitrogen gas and advised patient to keep quiet as he was rushing about too much.

July 5. Yesterday he went to a picnic, played a game of baseball and ran in a 100-yard race. This morning he spat up some blood. He is greatly worried and was advised to follow directions. Introduced 2000 c.c. nitrogen gas into the right pleural cavity going into the fifth interspace in front. The injection was well supported, absolutely no symptoms. Patient kept quiet for half an hour, then was allowed to go home "a wiser but a sadder man."

July 6. An hour after leaving the office he spat up a little blood again. The 2000 c.c. nitrogen gas given yesterday did not completely immobilize the lung. Respiratory sounds and râles are still heard at the apex. I tested the apparatus to make sure there was no leak —

none found. To-day introduced 1000 c.c. nitrogen gas without altering the pressure very much. It was positive, 8 cm. water at the end of the introduction. Tympany marked throughout right lung, no respiratory murmur or râles heard except very faint respiration at apex. Heart action good and normal rate.

REMARKS.

The improvement in the general condition of this patient has been remarkable. He has continued from the beginning to attend to his business and to live in the North End not in the best of hygienic surroundings. He raises very little sputum, which still shows few tubercle bacilli. I urged him to move into the country, which he finally did the middle of May. Against my advice he was married. He is following the treatment still and has promised to continue.

This is one of the most striking cases I have, showing the wonderful effect of a properly kept up artificial pneumothorax. I have no doubt that if this patient had been in the proper hygienic surroundings at the start there would be no tubercle bacilli in the sputum to-day.

CASE 12. M. D., 31, single. February 9, 1912. Plumber. Lives in the North End, Boston. *Family History.* Negative. *Past History.* Gonorrhea and syphilis eight years ago. *Present Illness.* On March 5, 1910, was suddenly taken in the night with a brisk hemoptysis and lost about a pint of blood. A second hemorrhage occurred a week later, during which he lost about eight ounces of blood. In two weeks was better and went back to work, though he was troubled with a cough and increasing weakness. He worked for two months when he had to give up on account of a third hemorrhage. Since then he has spat up blood in small amounts at varying intervals. Cough is very irritating, preventing sleep, pains throughout the chest and night sweats. Raises considerable thick yellowish sputum tinged with blood. Is very much discouraged. *Physical Examination.* Well developed and fairly nourished. Shows loss of weight, sallow complexion, cheeks sunken and eyes cavernous. Teeth, mouth and tongue in good condition. *Right Lung.* Dullness, increased tactile fremitus throughout, but more marked in upper third. Bronchovesicular breathing and moist râles, especially at apex and middle lobe. Some râles heard throughout lung. *Left Lung.* Distinct dullness and moist râles at apex.

February 9. X-ray of chest by Dr. Walter J. Dodd. Showing an extensive advanced bilateral process more marked on the right.

February 10. 100 c.c. nitrogen gas introduced into right pleural cavity, going into the sixth intercostal space in midaxillary line. The introduction was made slowly and carefully at varying intervals, measuring the intrathoracic pressure. At end of operation there was slight dyspnea and slight cardiac displacement. Very little pain. The nitrogen gas went mostly anteriorly.

February 14. No discomfort since the first introduction of nitrogen gas. 800 c.c. nitrogen gas injected in the same space. Manometer reading showed a positive pressure of 5 cm. water. A feeling of tension

in the chest and occasional sharp pain radiating to back. Tympany and absence of respiratory sounds and râles in front. Posteriorly respiratory sounds and râles heard distinctly in middle lobe. Scattered râles throughout back. Heart a little displaced to left but functioning normally. Feels well.

February 17. In front right chest respiratory sounds but no râles heard. In back loud respiratory sounds and râles heard; crepitant and moist râles especially in the middle and upper lobe. 800 c.c. nitrogen gas introduced in fifth interspace postaxillary line. Râles are still heard below the spine of scapula downward to middle lobe.

February 19. No troublesome cough. No night sweats, feels much stronger. 200 c.c. nitrogen gas injected.

February 23. Improvement continues. Weight 138 pounds. 300 c.c. nitrogen gas injected. Crepitant and moist râles are still heard in the back. Blood in sputum soon after injection.

February 29. Has been able to take long walks without dyspnea. Has a hearty appetite. 500 c.c. nitrogen injected. A feeling of tension throughout chest and a little pain at sight of puncture; an emphysematous area near site of puncture, causing no discomfort. The râles in the back not obliterated. Anteriorly pneumothorax is complete.

March 25. Patient coughs during the day. Pneumothorax is complete except for a patch in the back where râles are distinctly heard. 100 c.c. nitrogen injected. X-ray, taken by Dr. Walter J. Dodd, shows the middle lobe to be adherent, thus preventing a complete compression.

March 30. Very little sputum in the morning. No pains whatever. Attempted to introduce nitrogen in the back below angle of scapula and after 50 c.c. had been introduced injection was stopped on account of the pain.

Patient has come twice a week for examination and for replenishing the loss due to absorption. He has continued to improve, looks a great deal better and feels that he is on the road to recovery.

May 27. The patient was in the office for about two and a half hours this morning helping with other patients. He was the last one injected, 400 c.c. nitrogen gas being introduced at a high pressure, for the purpose of compressing the middle lobe. The manometer reading showed the pressure to be very high for it blew the water out of the manometer. The tension was relieved by allowing some of the gas to escape. The pressure was brought to 12 cm. water. Patient felt well but very full about the chest. Immediately after the site of the puncture had been strapped, he came down from the operating table and swooned. He soon revived and after reclining a short time on the couch felt better. He felt miserable for two days, complaining of pain in epigastrium and a feeling of fullness on taking a little food.

May 31. Feels well. X-ray taken by Dr. Holmes.

The pneumothorax is almost complete except for a part of middle lobe in the back, which is adherent. There is tympany throughout the anterior portion of the right chest. No respiratory or abnormal sounds heard. Coin sound.

In right back, region of middle lobe, moist râles heard. This portion



CASE XII. Extensive tuberculous process involving both lungs. More marked in right. Left base and apex less involved. Type of bilateral case that slowly but progressively improved under treatment.



CASE XII. Partial pneumothorax of right side. Complete pneumothorax impossible at this time owing to adhesions. Thin black lines extending across the lung indicate edge of retracted lung held by adhesions. Extensive process in left lung. Heart pushed to left by pneumothorax. The nitrogen gas is mostly in front of chest and is at a high pressure.

of the lung not yet collapsed. Several attempts made to enter pleural cavity here have failed.

June 3. Introduced 300 c.c. nitrogen gas into the pleural cavity, going into the fifth interspace just below angle of scapula behind. The pneumothorax needle passed through very thickened pleura. Patient stood the introduction well. The râles were not wholly obliterated.

June 7. "Feeling fine." Introduced 500 c.c. nitrogen gas into the fifth interspace in back. Well taken. At the end of the introduction manometer pressure registered 6 cm. water positive.

June 11. Patient was demonstrated to the Section on Tuberculosis of the Massachusetts Medical Society. Introduced 300 c.c. nitrogen gas, going into the sixth interspace anteriorly. The sputum has markedly decreased in amount; there is very little cough and the patient is happy.

June 14. Introduced 600 c.c. nitrogen gas into the sixth interspace below the angle of the scapula. A feeling of tightness about the chest. Heart action good, rate 72 throughout.

June 16. Noticed sputum streaked with little blood.

June 18. The condition of the left lung is very satisfactory, there are very few râles heard at apex. The respiratory sounds throughout are harsh and of an exaggerated character. The right chest anteriorly is tympanitic throughout, absolutely no respiratory sounds heard. In the back in an area corresponding to middle lobe there are crepitant râles heard. Introduced 800 c.c. nitrogen gas in the sixth interspace below angle of scapula. This amount appeared to obliterate the râles.

June 22. Doing well. I have been urging this patient to move from the North End but he is not able on account of his financial condition. A friend of his is taking him down the harbor in a steamer every day from now on. The nitrogen gas is very rapidly absorbed in the back as is evident by the râles heard. Introduced 800 c.c. nitrogen gas into the fifth interspace below angle of scapula. Râles obliterated. At end of introduction the pressure was positive 6 cm. water.

June 26. Condition the same as on previous date. Introduced 1000 c.c. nitrogen gas into the sixth interspace below angle of scapula. The pleural space must certainly have increased in size. The nitrogen gas under pressure is more rapidly absorbed.

June 30. 500 c.c. nitrogen introduced into fifth interspace below angle of scapula.

July 3. Has been going down the harbor every day for a week. Is also going to sleep aboard for awhile. Introduced 600 c.c. nitrogen gas as before. Well tolerated.

July 7. Has gained 4 pounds since he has been going down the harbor. General condition very satisfactory. No respiratory sounds heard in the right chest anteriorly. Râles and respiratory sounds heard in the right back. Introduced 1500 c.c. nitrogen gas into the sixth interspace below angle of scapula. No pain, some tightness about chest. Heart action good. No râles heard in the right back. Lung tympanitic throughout, coin sound heard throughout. The lung is immobile.

REMARKS.

This is an advanced bilateral case, presenting the one great obstacle in the treatment — adhesions. Old adhesions cannot be broken and therefore the lung cannot wholly collapse. The condition of this patient at the start was bad. The treatment has certainly improved his general condition and if it is continued and the patient placed in proper hygienic surroundings, I think we can rightfully expect more marked improvement. I have finally been able to produce a complete pneumothorax of the right lung and will maintain it so by frequent injections. The nitrogen gas is very rapidly absorbed where the pleura is thickened and there are adhesions. If this state of things continues for the summer there is every reason to believe that the patient will ultimately recover sufficiently to become self-supporting.

CASE 13. A. Z., 23, female, married. February 24, 1912. *Family History.* Negative. *Past History.* Unhappy married life. Has one child six years old. *Present Illness.* For the last three years has had a cough which started after a pleurisy of the left side. For the last four months has been getting worse, gradually getting weaker, losing flesh and a gradual but progressive sore throat has developed, which causes considerable pain and trouble in swallowing. Cough is troublesome, raises sputum with considerable effort, has chills in the afternoon and a rising temperature with sweating. Appetite poor. Tires easily. Has not menstruated for four months. *Physical Examination.* Fairly developed and poorly nourished. Marked loss of flesh. Skin dry and hot. Teeth and mouth in good condition. *Laryngological Examination.* Tuberculous involvement of larynx. X-ray taken by Dr. Walter J. Dodd. *Left Lung.* Dullness, pleural thickening, bronchial breathing and coarse moist râles throughout. *Right Lung.* Cavity between second and third rib. In upper third dullness, moist, coarse râles and amphoric breathing. An advanced case undertaken as "*ultima spes salutis*" on the insistence of the father and the patient.

March 1. Temperature 102°, pulse 120, respiration 24. 1000 c.c. nitrogen gas introduced into the fourth interspace in midaxillary line on the left. Patient stood introduction well, there being no untoward symptoms until night when the patient was restless on account of the pain at site of introduction. The nitrogen gas went mostly anteriorly, but apex beat was not displaced.

March 4. Patient feels fairly comfortable. Has raised considerable sputum much easier than before. 200 c.c. nitrogen gas injected — slight pain at site of introduction. The intrathoracic pressure was 8 cm. at end of introduction. A feeling of fullness in the chest. Weak, but in fair condition, pulse rate 120. The muscles of the chest wall are very thin. During an attack of coughing some of the nitrogen gas escaped through puncture into the tissues, producing a subcutaneous emphysema of moderate extent. Deep pressure being exerted over puncture, escape of gas ceased.

March 7. The patient was seen in consultation by Dr. Samuel Robinson. 1500 c.c. nitrogen gas introduced without displacing the heart. At the end of the introduction, the patient was in good shape.

Pneumothorax complete except for moist râles at left apex and above the spine of the scapula behind. Very little change in the right lung.

March 11. Patient has not been very well. The throat has become worse and patient cannot take proper nourishment. Cough is less and expectoration a little easier. Fever and sweating continues. 150 c.c. nitrogen gas introduced into sixth interspace below angle of scapula behind on the left. Very faint respiratory oscillation obtained, and considerable pain felt during the introduction. Intrathoracic pressure 12 cm. of water. Probably the gas went into a space bounded by adhesions.

March 15. The condition of patient is worse. She is able to swallow only with a great deal of pain. She is in a weakened condition. Decided not to continue injections.

Patient died April 10th.

REMARKS.

An extremely unfavorable case, not only on account of the lung condition but also on account of the serious laryngeal complication which prevented the patient from taking a proper amount of nourishment. DaGradi has treated three cases of laryngeal tuberculosis secondary to the lung and reports good results in two cases. Ulcerative processes in the larynx may heal when infective sputum from the diseased lung ceases to pass over them.

CASE 14. V. L., 32, married. April 28, 1912. Farm laborer in Arlington, Mass. This is the only severe case of hemoptysis that I have treated with artificial pneumothorax, and it is very interesting and instructive. Family and past history negative. *Present Illness.* Sixteen days ago came home from work not feeling well and complaining of chilliness. For several days previous had a slight cough with clear sputum. He went to a physician's office that evening on account of cough and the chilliness. That night, after going to bed, he coughed and spat up a basinful of blood. Cough persisted, and chilliness and fever with night sweats came on. The sputum continued bloody up to April 28, when I first saw him. On that day he had had a second hemorrhage. Patient looked haggard, cough was troublesome, and sputum bloody. Dyspnea and was apparently in great discomfort from pain in left chest. The cheeks were flushed and the eyes were sunken. Well developed and fairly nourished; chest well formed. Apex beat visible in nipple line. *Left Lung.* Dullness and bronchial breathing, increased fremitus in upper half of lung front and back; moist râles throughout but more marked in middle lobe. *Right Lung.* Squeaks only. Temperature 102°, pulse 120, respiration 36.

I introduced 1800 c.c. of nitrogen gas into left pleura, going into the fifth interspace in midaxillary line. The nitrogen was introduced slowly, employing 30 minutes in doing so, and meanwhile examining the condition of the heart. The patient stood the introduction of nitrogen gas well. An hour afterwards the patient was left fairly comfortable, but complained of a feeling of tension in the left chest and of inability to take a long breath. His pulse was 130, small but

good. He passed an uncomfortable night on account of the pain at site of the injection and on account of the cough. The heart was markedly pushed to the right, there was tympany throughout the left chest, no râles and very faint breath sounds. Pneumothorax apparently complete.

April 29. Cough persists, expectoration still bloody, not uncomfortable, and breath sounds more audible but no râles. Temperature 101°, pulse 120, respiration 38.

April 30. Temperature 99°, pulse 102, respiration 32. Cough persistent and sputum still bloody. The pneumothorax was not complete for lung was partially mobile. Decided not to give a second injection of nitrogen gas.

May 1. Late in the night spat up a cup of blood. I was sent for. The patient was greatly worried on account of the blood he had raised. An examination of the left lung showed the lung was mobile, as was evident by the respiratory sounds throughout and the return of the râles, though on percussion there was tympany throughout left chest.

I introduced 1200 c.c. nitrogen gas, going into the fifth interspace midaxillary line, the introduction being made very slowly and the lung being frequently examined with the stethoscope. I stopped the nitrogen gas when the râles and respiratory sounds were obliterated. At the end of the introduction, the intrathoracic pressure was 10 c.c. of water; there was an almost complete dextrocardia. The pulse was 130, weak, irregular and of poor quality. The patient complained of a feeling of tension in the chest, pain and inability to take a long breath. In the course of half an hour the pulse became regular, rate 120, of good quality. In an hour and a half he was fairly comfortable, the pulse was good, and the cough was not troublesome.

May 2. "The best night I have had since I have been sick," were the patient's words the next morning. No night sweats, very little cough, sputum tinged with blood. Temperature 99°, pulse 118, respiration 36. There were scattered squeaks in right lung and breath sounds markedly increased.

May 3. Doing well. Temperature 99°, pulse 118, respiration 36. On stethoscopic examination the left lung is found slightly mobile as is evident by the slight respiratory sounds and the râles heard. I wished to keep the lung as completely immobilized as possible on account of the hemorrhages the patient had had, and feared a repetition if the lung became mobile. There were injected 200 c.c. of nitrogen in the same space as before. This obliterated the respiratory sounds and râles. The patient was left feeling comfortable. Pulse 120, respiration 36.

May 4. Temperature 99°, pulse 102, respiration 30. Feels better — some pain on coughing at site of injection, the sputum is still bloody but diminished in quantity. Complains of pain in epigastrium the liver is found pushed down. Appetite increasing.

May 5, 6, 7. Condition continues good, coughs less, very little blood in sputum; no night sweats and temperature normal. There are squeaks heard in right lung.

May 9. Passed a fair night. Pain persists at site of injection. No

more blood in sputum. Expectoration is loose and mucous in character. Stethoscopic examination shows pneumothorax to be of such a volume as to keep lung immobilized. There are râles and squeaks at base of the right lung, probably due to pressure of left pneumothorax on the right lung.

May 12. There has been no blood in sputum, cough is loose and the expectoration is frothy. There is still some dyspnea on exertion. Temperature 99°, pulse 108, respiration 36. Appetite increasing.

May 14. Temperature 98.5°, pulse 102, respiration 24. Breathing easier, and says he is able to take a long breath now without discomfort. Has been resting and sleeping well. The condition of left lung remains unchanged. The râles and squeaks of the right lung have cleared.

May 19. The patient was found up and taking a walk. Very little cough and sputum. Gaining in strength.

May 23. Came from Arlington to Boston to the office. Feels stronger. Had an x-ray taken by Dr. Walter J. Dodd, shows a complete pneumothorax of left lung. Repeated sputum examinations fail to find tubercle bacilli.

May 28. The patient is doing well, is gaining in strength and is out of doors every day.

REMARKS.

John B. Hawes 2nd, in a recent publication says, "A hemorrhage from the mouth in the absence of a definite source elsewhere, which can entirely and satisfactorily explain the bleeding, should be considered as positive evidence of pulmonary tuberculosis, even if the physical signs in the lung are of the slightest." In this case the signs in the left lung were marked. There was no doubt as to the diagnosis. The serious and menacing condition of the patient justified the energetic treatment and I believe it saved the patient's life. If at any time the patient's condition had become worse, on account of the heart displacement or the pressure on the other lung, it would have been an easy matter to relieve condition by the withdrawal of some of the gas from the chest. This case illustrates very well the efficiency of the treatment in hemoptysis. It must be remembered that this patient had been under medical treatment for 16 days previously and was progressively getting worse. There has been no replenishment of nitrogen gas since the third injection. Altogether the patient has received 3200 c.c. nitrogen, the pneumothorax is complete, as shown by the physical examination and the x-ray taken May 23. The condition of non-compressed lung is good, the heart is still displaced to the right, but causing no untoward symptoms. There is very little coughing and a negligent quantity of sputum. The pneumothorax will be allowed to take care of itself and the patient kept under observation for a month at least before being allowed to go to work.

June 11, 1912. Shown to the Section on Tuberculosis of the Massachusetts Medical Society. The patient is feeling fine, has gained in weight, has no cough or sputum. Is going back to work. The pneumothorax is still complete and the heart is still displaced to the right.

CASE 15. Edward R., 45, married. May 20, 1912. Boiler worker, East Boston. Referred by Dr. Sissa. *Family History*. Negative. *Past History*. Malaria as a young man. Denies venereal disease. Married 20 years. Five children, all well. *Present Illness*. Last July not feeling well on account of cough and weakness, he went to a hospital for examination where he was told he had consumption. He was sent to a day camp where he stayed for two months without improving and later entered the hospital where he remained until March, when he left the hospital feeling worse. At present cough is very troublesome with a great deal of sputum, night sweats, slight chilly sensation and general weakness. Appetite is poor. Is unable to sleep on left side. *Physical Examination*. Well developed and fairly nourished, fair color, mouth and teeth good. Pupils equal and react. Knee-jerks normal. *Chest*. Well formed. *Left Lung*. Dullness from third rib in front upward and from the spine of scapula behind. Moist, coarse râles throughout lung more marked from second rib in front to apex. Bronchovesicular breathing. *Right Lung*. Dullness at apex, bronchovesicular breathing, increased fremitus, fine crepitant râles at angle of scapula behind. X-ray examination shows an extensive bilateral process more marked on the left. Heart and blood vessels apparently normal. Nothing noted in abdomen. *Urine*. No sugar or albumen. Distressing cough throughout examination.

May 21. Introduced 500 c.c. nitrogen gas into left pleural cavity going into the fifth interspace in midaxillary line.

Absolutely no symptoms. There never appeared any untoward symptoms. At the fifth injection which was made in the sixth interspace below angle of scapula patient felt considerable pain which disappeared on the following day. The sixth, tenth and seventeenth injections also caused some pain.

REMARKS.

It has always been very difficult to maintain the pneumothorax complete even by frequent replenishing of nitrogen. Every advanced bilateral case of this series has shown this same difficulty.

After the fifth injection the patient was able to sleep on the left side, his appetite improved and he began to regain his weight. The cough and expectoration have markedly diminished, he feels stronger and is able to do some work about the house. For the last three Sundays he has gone fishing in the harbor and I have encouraged him to do so on other days.

There is a marked improvement in all his symptoms and he is a happier man now than when he began treatment.

The pain that he has experienced on three different occasions are undoubtedly due to pleural adhesions which are not uncommon in these advanced cases.

CASE 16. V. B., 43, married. May 21, 1912. Fruit dealer. Lives in East Boston. Referred by Dr. Sissa. *Family History*. Negative. *Past History*. Six years ago had pleuropneumonia and was ill one year. He went to Italy and came back six months later completely recovered and weighing 175 pounds. *Present Illness*. Ten months

ago a cough began, which was very troublesome. A great deal of sputum. To-day noticed blood in sputum for the first time. Pain across chest, due to continued coughing. General weakness, tires easily, appetite poor, bowels regular. Has been unable to work for the last ten months. *Physical Examination.* Well developed and fairly nourished. Evident loss of weight, worried, harrassing cough throughout examination. Mouth and teeth good. Chest well formed. *Left Lung.* Upper third front dullness, bronchial breathing, moist coarse râles, more marked at apex. From angle of scapula behind upward, dullness and râles. Râles heard throughout lung. *Right Lung.* Area of consolidation from second rib upward in front with moist coarse râles. Moist, fine râles in upper third, back. X-ray taken by Dr. Walter J. Dodd. Heart apparently normal. No albumen or sugar in urine.

First injection May 22. Introduced 500 c.c. nitrogen gas into left pleural cavity, going in the fifth interspace inside midaxillary line. Little pain, insufflation well supported.

May 24. Has been troubled with pain on left side up to this morning, but otherwise no untoward symptoms. 1000 c.c. nitrogen gas injected as before. No symptoms whatever except for a slight tightness. The gas is mostly in front of chest. Heart is slightly displaced to the right. Pulse of good quality and regular. The cough has been looser and expectoration easier and increased.

May 27. Pneumothorax not complete. Lung mobile as is evident by the fine râles and respiratory sounds heard from fourth rib in front and from spine of the scapula behind. 700 c.c. nitrogen gas introduced. The lung is tympanitic throughout front and back. A few râles heard at apex. Right lung is hyperresonant, marked increased breathing. Some râles heard at apex. Cough has markedly diminished.

May 30. Feels a little better, is sleeping a little better, but appetite has been poor. 400 c.c. nitrogen gas injected; before the introduction of gas the pressure was markedly negative. After the introduction of 200 c.c. it became positive and after 200 c.c. more had been introduced, it was 6 cm. positive.

June 8. Injections of 500, 300 and 200 c.c. of gas on June 1, 3 and 4 respectively. Since the last injection has raised considerable sputum without any trouble. Feeling much better. Coughs very little. 1000 c.c. nitrogen gas injected without any pain whatever.

June 10. Eats and sleeps better. Coughs a little more in the morning but has no cough at night now. Is a little stronger, left lung is tympanitic throughout the front. Very few scattered râles from third rib upward. Weak respiratory sounds in front. Râles plainly heard in left back. Introduced 400 c.c. nitrogen gas, into midaxillary line fifth interspace, most of the gas entering the front of the chest. No râles in front. Scattered râles throughout left back.

Manometer showed feeble respiratory oscillations. The nitrogen was introduced at a high pressure. Undoubtedly the pleura in the back is thickened and the pleural cavity is markedly diminished. Considerable pain referred to left hypochondrium. Pain lasted about

fifteen minutes. Pulse was good throughout. Rate 84. Heart slightly displaced to right. The right lung is hyperresonant throughout. Increased respiratory sounds, bronchovesicular breathing at apex. Very few râles heard.

June 11. He was shown to the Section on Tuberculosis of the Massachusetts Medical Society.

June 14 to July 5. Condition continues good. He has come every three days for replenishing of nitrogen gas. Absorption is slower now needing less nitrogen gas at each injection to keep the lung collapsed.

REMARKS.

This patient was of very dirty habits when he came under treatment. He spat everywhere. I have trained him gradually. Under treatment he has improved mentally and physically. He is happier, sleeps and eats well and has very little sputum and hardly any cough except in the morning.

One day after a rather trying introduction of nitrogen gas he came back greatly alarmed because he had spat up sputum streaked with blood. That was due to my having punctured the lung with the pneumothorax needle before introducing nitrogen gas. No more harm results from this than from puncturing lung during a thoracentesis provided you do *not induce nitrogen gas into the lung*.

CASE 17. Eleonora S., 30, married. May 17, 1912. Housewife. North End, Boston. *Family History*. Negative. *Past History*. Five years ago had a right sided pleurisy and later a troublesome dry cough with pain on right side. She went to Italy where she improved in health but the dry cough persisted. She was married two years ago. *Present Illness*. During the last two months of her recent pregnancy she had considerable pain on the right side and the cough was aggravated. After the confinement the cough and pain became worse. She also began to have chills, night sweats and fever, with a small amount of sputum. *Physical Examination*. Fairly developed and poorly nourished, thin. Pupils equal, react to light. Mouth and teeth in good condition. Knee-jerks normal. *Chest*. Breasts moderately engorged with milk. Left side of chest moves more than right. *Right lung*. Dullness from third rib in front to apex with increased fremitus and râles. Between the third and fourth ribs is an area the size of a half silver dollar where amphoric breathing is heard. Dullness and râles throughout lower back. Pleural rub in the sixth space midaxillary line. *Left Lung*. Slight dullness at apex with râles and bronchovesicular breathing. Moist râles at the base. X-ray examination showed an extensive bilateral process, much marked on the right, with a cavity and pleural adhesions. Heart apparently normal but rapid in rate, 100. Abdomen, nothing noted. Uterus involuted and apparently normal. There is a moderate amount of lochia.

This is an advanced bilateral case with marked active lesions. Tubercle bacilli in sputum. Temperature 101°, pulse 100, respiration 22. Treated at home.

May 18. Injected 500 c.c. nitrogen gas, going into the fifth interspace midaxillary line on the right. The injection was well tolerated.

Six hours after the injection she began to have pain on the right side with some dyspnea. The pain continued for three days. She had chills and fever. Very little cough but painful. On the fourth day pain began to diminish and gradually disappeared. On the advice of another physician who was called during my absence from town, she discontinued the treatment. Meanwhile she moved out of town.

REMARKS.

This is the only case of the series that has stopped treatment. Undoubtedly it would have been a very difficult case to handle had she remained. The pain she experienced six hours after the action of the morphia had stopped was due to the pleural adhesions which were present and had been stretched by the nitrogen gas. No worthy conclusions can be drawn in this case as the result of the treatment. While this was in press patient asked to be taken again under treatment.

CASE 18. Salvatore D., 18, single. December 7, 1911. Shoe shop worker. Chelsea. *Family History*. One sister died of pulmonary tuberculosis last year, otherwise negative. *Past History*. Subject to colds and slight cough in the winter but never sick abed. Denies venereal disease. *Present Illness*. For the last month has been losing his appetite and has grown weaker. An increasing troublesome cough has developed, on several occasions has spat blood. Yesterday spat up a cupful of blood, had a chill and later fever. Feels "all in." Pain on the left side. *Physical Examination*. Well developed and nourished, sallow complexion, apathetic, some dyspnea on slight exertion. Pupils equal and react, mouth and teeth in good condition. *Left Lung*. Dullness throughout left chest in front with slightly increased fremitus and râles at apex. *Right Lung*. Slight dullness at apex with bronchovesicular breathing. No râles anywhere, lung mobile throughout. *Heart* apparently normal but rate rapid, 100. Abdomen negative. Reflexes normal. Advised patient to go home and go to bed.

On the next day was called to see him as he had had a hemorrhage having raised a cuspidorful of blood. He kept raising blood in spite of medicinal palliative measures. His condition continually becoming worse, Dr. Samuel Robinson was called in consultation as to the advisability of doing an artificial pneumothorax on the left lung, from which the hemorrhage came. The temperature was 102°, pulse 110, respiration 24. Tubercle bacilli in sputum.

December 8. 800 c.c. nitrogen gas were injected into the fifth interspace midaxillary line on the left side. He stood the injection well, but the pulse became feeble, the rate increasing to 130. Twenty minutes later he complained of a great deal of pain on the injected side, necessitating a hypodermic injection of morphia. He passed a restless night. The next morning he had a second hemorrhage, thus making him still weaker. A second injection of nitrogen gas was made, 500 c.c. being given. He passed a comfortable day with very little cough; the sputum continued bloody.

At night he had a severe chill with a temperature of 104°, pulse 130, respiration 30. He gradually became weaker and died December 12.

REMARKS.

An acute rapid bilateral phthisis with hemorrhage; unfavorable under any form of treatment.

CASE 19. James F. P., 48, married. May 26, 1912. *Family History.* Negative. *Past History as Given by His Physician:* "In November, 1908, he had an attack of gripe while working in Boston. He made a poor recovery and I with two other physicians saw him the following month. At that time tuberculosis was very much in evidence. He went to Greylock Rest in the Berkshires for six weeks, then to Rutland Sanatorium; he remained there for a short time and was advised by the attending physician to go West. During the last six weeks of his stay in Rutland he had one or more hemorrhages and had a very high temperature. He went to Denver, Colorado, and Silver City, New Mexico. He did not improve and came home to Worcester and has remained at home ever since. He has had very good care and does not seem to have very much trouble except at intervals. The stomach and bowels have been bad and cause him no end of suffering. He has had no temperature for the past year and the sputum remains about the same all the time. He has been losing weight." Coughs a great deal, especially in the morning and raises large amount of sputum. No night sweats. Appetite is good, bowels regular. Sleeps fairly well. *Physical Examination.* Weight, 134 pounds. Well developed and fairly nourished, color fair, pupils equal and react, mouth and teeth in good condition. *Chest.* Uneven, marked depression of right chest, left side moves more than right. *Right Lung.* Dullness bordering on flatness throughout right lung from fifth rib upward, diminished respiratory sounds. Coarse and fine râles throughout, more marked at apex. At fourth rib in front in an area the size of a twenty-five cent piece there is harsh amphoric breathing. Dullness throughout the back with weak voice sounds. Crepitant and moist râles at the base and above angle of scapula. *Left Lung.* Fine crepitant râles at apex, bronchial breathing. Few moist râles at the base. X-ray examination shows an extensive process on the right with a small cavity in front. The fluoroscope shows lung to be adherent to the diaphragm. Mottling throughout left lung. Thoracic aorta apparently normal. Heart apparently normal. Abdomen, negative. Reflexes normal. No sugar or albumen in the urine.

An advanced active bilateral case; the progressive decrease in weight was ascribed to the tuberculous process in view of absence of other causes. Temperature normal, pulse 80, respiration 20.

May 27. Introduced 550 c.c. nitrogen gas into the right pleural cavity going into the fifth interspace outside nipple line. There were absolutely no symptoms.

May 29. Has raised same amount of sputum and he has not felt anything unusual. Introduced 500 c.c. nitrogen gas into the right pleura. A sensation of fullness noted. Pulse kept good rate, 74 throughout.

June 1. Raised more sputum than usual and it was more easily expelled; otherwise nothing noted. Introduced 400 c.c. nitrogen gas.

A sensation of tightness felt. The gas was going mostly into the front of the chest. Râles still heard at apex and in the right back. Respiratory sounds diminished. Increased respiratory sounds in the left lung.

June 3. Tight feeling continued for twenty-four hours, raises more sputum now. On examination shows that the nitrogen gas has been mostly absorbed, as is evident by the respiratory and abnormal sounds heard. Introduced 150 c.c. nitrogen gas. Tight feeling throughout chest, some pain in the shoulder. The pain is not severe. There is tympany throughout the anterior portion of chest, few râles faintly heard at the apex. Diminished respiratory sounds in the back. The pneumothorax is not complete.

June 6. 150 c.c. nitrogen gas introduced. A heavy feeling was felt, with slight pains in the right shoulder. After the introduction of the gas the pressure was not markedly altered. At the beginning it was negative, at the end it was 6 cm. of water positive. After five minutes the manometer reading showed the pressure to be even. The heart rate kept the same, 74 throughout.

There were no râles heard in front and but few râles made out in the right back. Respiratory sounds absent except in the back, where they were very faintly heard.

The left lung was hyperresonant throughout the front and back with increased respiratory sounds of a rather harsh character. A few râles heard at the apex.

June 15. Since last injection has raised considerable sputum, otherwise has been feeling well. On examination respiratory sounds heard throughout right lung; fine dry râles at apex and back; slight tympany throughout right chest. Increased respiratory sounds on the left. Few râles heard.

Introduced 900 c.c. nitrogen gas. This amount did not completely compress lung, as was evident by the râles heard at right apex — though there were no râles heard in any other part of the right lung. The pulse rate kept steadily at 78; the heart was displaced 3 cm. outside nipple line. Marked increase respiration on the left lung. The manometer at that end of the introduction showed a positive pressure of 6 cm.

June 19. 200 c.c. nitrogen gas introduced; this amount has completely obliterated the râles throughout the lung.

June 26. Pneumothorax partially absorbed. 300 c.c. nitrogen gas introduced.

June 27. 150 c.c. nitrogen gas introduced. On physical examination the lung seems to be fully compressed as is evident by absence of râles and very feeble respiratory sounds.

REMARKS.

It is one month since this patient began treatment. When he came he was losing one pound a week, had considerable digestive disturbance and a general feeling of weakness. During the treatment he has lost one pound, has no digestive disturbances, eats better and feels better mentally and physically.

The process in the left lung has certainly not progressed.

In many cases artificial pneumothorax prepares the ground for the ultimate recovery, and in many other cases gives certain symptomatic relief unable to be gotten from other methods. Final recovery must always be brought about by the organism itself, i.e., the increased resistance, etc. When the vital resources of the body are gone as in the galloping form artificial pneumothorax does nothing.

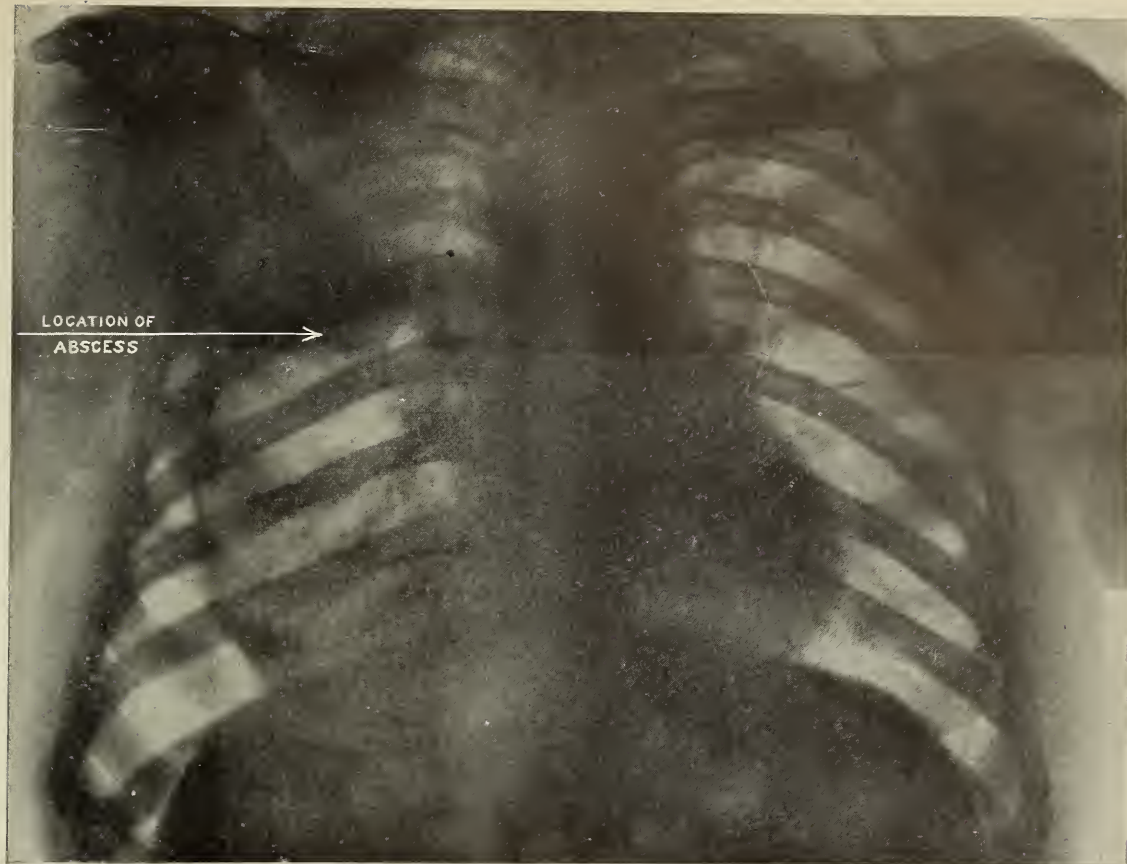
CASE 20. Peter W. C., 28. *June 3, 1912.* Machinist, Belmont, Mass. *Family History.* Negative. *Past History.* Nineteen years in the United States. Has always worked inside. *Present Illness.* One year ago caught cold, was ill about one month with it. A month later got rheumatism from which he was laid up about two months. He worked for five weeks when he took sick again with a cough, pain in the left side and fever. Night sweats, great deal of cough throughout the day and large amount of expectoration. Has fever and chills almost every day. Increasing weakness and loss of strength. Appetite is good, sleeps well when cough doesn't bother him. *Physical Examination.* Fairly developed and poorly nourished, emaciated and dyspneic. Pupils equal and react; tongue, mouth and teeth good. *Chest.* Symmetrical, right side moves more than left. *Left Lung.* On the left, from fourth rib upward, dullness, increased fremitus; bronchovesicular breathing and moist râles at apex—fine crepitant râles over consolidated area. In back marked dullness and increased fremitus from lower end of scapula extending above the spine, fine crepitant râles. Lung is mobile throughout. *Right Lung.* Good resonance throughout, occasional moist râle at apex. X-ray examination shows extensive process on the left, right lung little involved. *Heart.* Apex beat inside nipple line, rate 130, no abnormal sounds made out. Abdomen, nothing noted. Knee-jerks apparently normal. Temperature 102°, pulse 130, respiration 24. Tubercle bacilli in the sputum.

First Injection. 200 c.c. nitrogen gas introduced into the left fifth interspace in midaxillary line. Patient stood the introduction well, there being absolutely no symptoms. After keeping quiet for half an hour dressed and went away. At the end of the introduction of nitrogen the pulse was 122.

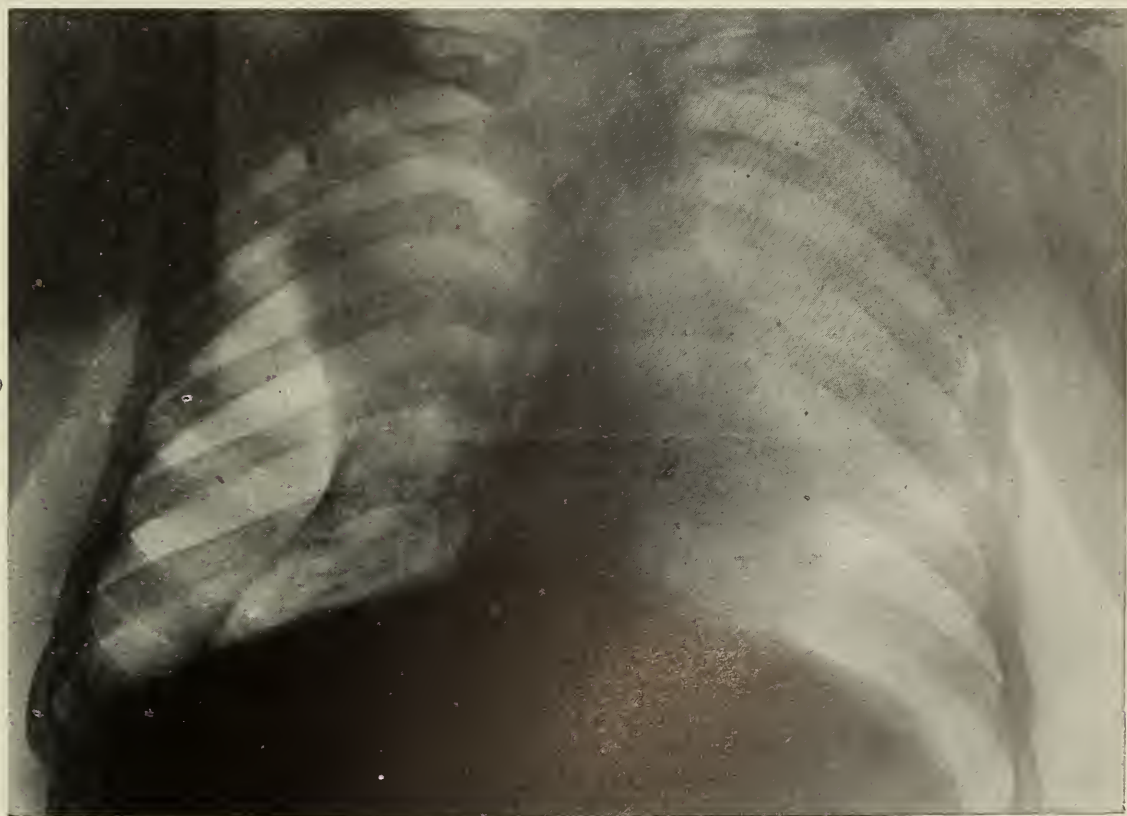
June 5. Has had no pain. Has been feeling about the same. 600 c.c. nitrogen gas injected into the sixth interspace below angle of scapula. Felt some pain all over the anterior left side of chest. Pain soon subsided. After resting half an hour patient left. Temperature 101°, pulse 120, respiration 24.

June 7. Has been raising more sputum than usual but it has been much easier to raise. Feels a little better. Temperature 98.5°, pulse 120, respiration 22. 500 c.c. nitrogen gas introduced into the sixth interspace below angle of scapula. Felt some pain over anterior part of left chest. In ten minutes pain subsided. After resting twenty minutes patient got up.

There is tympany throughout left chest in front and back. No râles heard and the respiratory sounds are markedly diminished. The nitrogen gas is mostly in the front of the chest. The right side shows increased respiratory sounds which are harsh in character. No râles



CASE XXI. *Lung Abscess*. No evidence of tuberculosis. Abscess located between second and third interspace right side. Partial pneumothorax right base extending up axillary border.



CASE XXI. *Lung Abscess*. Same case after injection of more gas showing greater retraction of lung. Left lung normal.

heard. The heart is displaced two fingers' breadth to the right. Its action is good but still rapid.

June 9. Has been raising double the amount of sputum since the last injection. Had considerable cough during the night. This morning sputum was streaked with blood. "No pains, feeling good." Temperature 100.5°, pulse 120, respiration 22. Still evidence of pneumothorax. Injected 600 c.c. nitrogen gas. No pain.

June 13. Since the last introduction of nitrogen gas at the office I have had patient remain quiet at home on account of the extreme hot weather, and I have gone to his home. Appetite has not been so good since the hot spell. Cough and sputum diminished.

Pneumothorax marked up to the fourth rib in front. Respiration marked at left apex — no râles heard. Respiration in right lung much increased throughout, no râles. Temperature 99.5°; pulse 122; respiration 24. Injected 700 c.c. nitrogen gas into left pleural sac. Feeling of tension about chest at end of introduction. Manometer showed a positive pressure of 4 cm.

June 22. Appetite good, gaining in strength, coughing less and raising very little sputum. X-ray by Dr. Walter J. Dodd shows lung to be collapsed up to fourth rib anteriorly. Introduced 300 c.c. nitrogen gas into fourth interspace midaxillary line on left.

Apparently this completely compressed the lung. No râles heard, no respiratory sounds. Coin sound demonstrable throughout left lung. Temperature 100°, pulse 120, respiration 24.

June 23. X-ray examination showed the lung to be totally collapsed except from the third rib up. The apex of the lung is always very difficult to collapse even when there are no adhesions. Indurated or calcified foci may prevent compression for a time.

REMARKS.

It appears from this case that in such an early acute active case, especially when the process is not very marked in the non-compressed lung, the nitrogen gas is retained and smaller amounts are necessary to keep the lung collapsed. The outlook of this case is favorable.

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DISCUSSION OF ARTICLE XIX.

DR. S. ROBINSON, Boston: Dr. Balboni has referred to me in connection with this work, but I can only say that the beautiful piece of work that he has carried on I am in no way responsible for. I know of no piece of work done in this city that has necessitated a greater expenditure of time and energy or has been carried on with a greater persistency and patience than the work that has been carried on by Dr. Balboni. I have had every opportunity to scrutinize the details of his work. The State of Massachusetts has been noted for its conservatism, and I think still is, and I can picture in my mind the manner in which you are receiving this enthusiasm by one who has been through this treatment. I think possibly I might state my views about the status of the treatment as it now stands here and elsewhere.

In Europe four years ago I became interested in its surgical aspects. I met Dr. Brauer, of Marburg, who was employing the artificial pneumothorax treatment and he gave me an opportunity to see and study his patients. I was very much surprised at the results that he was obtaining. He employed the fluoroscope and made daily observations of his patients. I was greatly interested in studying his work and I came back here to find out whether his enthusiasm was justified. I was familiar with Forlanini's work and that of Dr. Murphy in Chicago in connection with his surgical research and I started in here perfectly willing to prove the treatment of no value if this were the case. I was met by almost insuperable obstacles; the opposition was very marked; there was great lack of enthusiasm and on that account I found it very hard to get patients.

Finally, by raising some money, the Massachusetts General Hospital was courteous enough to put up some tents in the out-patient yard and with the assistance of Dr. Floyd for two summers I have attempted to study the cases and treatment. I think you should take this attitude regarding the treatment — that there is no question that a certain group of cases which have passed the possibility of improving by the usual methods of hygiene and have not become too far advanced is susceptible to this treatment;

that this treatment will in such patients invariably result in improvement. The patients who have been treated have always been relieved of the symptoms which Dr. Balboni has gone into. As for the cures in the cases you must judge by the literature and the cases that are reported. Dr. Lapham in Atlantic City last week, in the Medical Section, said that she was surprised to learn that forty per cent of advanced cases of tuberculosis had been cured in this treatment. We have had twenty-seven advanced cases in our studies. Out of twenty-seven we have apparently arrested the process of the disease in six, that is to say, it is quiescent in six. If you will follow the series of Dr. Forlanini you will see that there is a low percentage of cures. The greatest argument in favor is the considerable improvement obtained by giving it a fair trial. There is very good reason to expect an arrest of the disease, provided—and I think this is the crucial point—one carries out the discipline faithfully, but as Dr. Balboni said the amount of nitrogen injected should be steadily increased rather than allowed to decrease. I have had an opportunity to follow these people and I am telling you this because I believe it is the view of many. I have a great deal of enthusiasm and great faith in it. If I were running a tuberculosis sanatorium to-day I should employ the treatment regularly with a certain group of patients.

If I may, I will show you my apparatus. It is the apparatus built upon the same principle as that of Dr. Balboni but a little more compact and more easily carried.

DR. A. T. CABOT, Boston: The subject of this treatment of course brings up the whole subject of surgical treatment of tuberculosis, and I am very much interested in what Dr. Balboni has said in regard to the conditions he has found. This process set up in these cases is exactly the process which has been known for twenty-five years as helping us in our work in curing surgical tuberculosis in other parts of the body. The cure of surgical tuberculosis is brought about by enabling the body to throw up a wall of fibrous tissue which shuts in the tuberculous process and keeps it confined.

Twenty years ago I wrote a paper on the treatment of tuberculous peritonitis. Peritonitis was one of the early

surgical triumphs in the field of tuberculosis. The abdominal wall was covered with tubercles, so that when you put your hand in the abdomen it felt like nothing so much as putting the hand in a bag of shot; to see a patient get well and remain well for years—as I have patients now that I have operated on twelve or fifteen years ago—shows us that by removing the fluid you have made a change in the conditions in such a way that nature is enabled to take hold and complete the cure. My explanation of the operation in that old paper was that it simply clamped the abdominal wall down on the intestine and held them together by adhesions to the front wall. You would have tissue surrounding those walls on all sides and shutting them in in an innocuous condition. I have no doubt those cases I speak of as cures where these abdominal cavities were opened you will find have calcareous masses of destroyed tubercles. In the course of years, if they go on for two or three years, I should suppose that in those lungs would be found fibrous walls with the process so shut in that it could not break out. This is very interesting to me as a surgeon.

ARTICLE XX.

THE USE OF LACTIC ACID SOURED MILK
AND LACTIC ACID BACILLI IN
PULMONARY TUBERCULOSIS

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THE USE OF LACTIC ACID SOURED MILK AND LACTIC ACID BACILLI IN PULMONARY TUBERCULOSIS.

So many excessive claims have been advanced of late in connection with the use of buttermilk and the different lactic acid ferments in the various branches of medicine, that some hesitancy is felt in approaching what is unfortunately a somewhat deservedly discredited subject. It is our feeling, however, based upon several years of observation and experience that somewhere between the original extreme claims of Metchnikoff and his followers on the one hand, and the flat denial of the ultra scientific on the other, rests a definite and well established field of usefulness.

A review of the already voluminous, contradictory and at times erratic literature of this much debated subject is apart from the purpose of the present paper. Every medical reader is familiar with its history, from its employment in ancient times as an essential element in the diet of certain races, and its popularization in 1908 at the hands of Metchnikoff and his pupils, to its recent industrial exploitation as a modern "elixir of life" in the hands of the milk dealer and at the soda fountain of the average drug store. Our purpose, therefore, is neither the support of extravagant claims nor the advancement of new experimental evidence, but the simple presentation of certain types of cases in which it has proved of undoubted value, the method of application and the means we have adopted for preparing it upon a relatively large scale in hospital practice, together with a brief consideration of the particular ferment employed, and our experience with other lactic acid cultures.

The essential problem in the treatment of pulmonary tuberculosis and its complications is a metabolic one. It is around this central point that its pathology finds expression, and it is towards the correction of these various perversions that our present hygienic and dietary efforts are directed. It follows, therefore, that any therapeutic agent which will aid, however slightly, in time of need, a failing anabolism, which will diminish the toxemia, or which will modify a troublesome and debilitating complication, is worthy of inclusion in the list of what is at best an all too slender armamentarium.

Every clinician who has concerned himself extensively with the care of tuberculous patients has been impressed with the prostrating effect of the obstinate diarrhea, alternating very often with intervals of constipation which is a not infrequent complication of well established, or advanced pulmonary tuberculosis. That the larger percentage of these cases are functional only has been indicated by a somewhat extensive study of the feces in the laboratories of the Rutland State Sanatorium, and their toxic origin is strongly suggested. It is in connection with this type of individual, as well as in cases of actual tubercular enteritis that the employment of lactic acid soured milk has afforded the maximum benefit, both as a dietary measure in support of energy and in tissue repair, and as an agent favorably modifying the symptoms and controlling the diarrhea. Its range of usefulness extends over almost the entire field of gastrointestinal affections encountered in connection with our sanatorium work. That there are occasional cases unbenefited is not to be denied. The factors at work are not sufficiently clear at present to determine with certainty the suitability in every instance of a given individual, and it would even appear that there are types in which its employment is attended with symptoms which frankly contraindicate its use. Whilst small regard is entertained here

for the old pernicious idea of so-called forced feeding in tuberculosis, the diet is a liberal one, and its protein composition necessarily high. Couple this fact with the common incidence of the necessity of restricted exercise, and we have a condition which, when considered in connection with the well-known strong natural tendency in this direction in tuberculosis, is fruitful of almost every variety of gastrointestinal complaint.

In the course of our routine urine examinations, both in the case of each recently admitted patient, and those of longer residence in whom a repeated examination is indicated, the fact is elicited that the presence of varying degrees of indicanuria is the rule. Its probable intestinal autotoxemic origin is indicated by the associated increase in the coefficient of Bauman Morax¹ in a certain number of cases, in whom the exhibition of a buttermilk diet was followed by a disappearance of the indican and a return to normal of the ethereal sulphates. Cases have been encountered in whom the gastrointestinal disturbance was so severe as to render the usual restricted dietary measures of no avail. To the exclusion of all other food material certain of these individuals have subsisted upon buttermilk alone, for varying periods, with a degree of toleration not to be accorded to any other variety of food. It may be of interest here, in this connection as exemplifying the conditions above mentioned, to offer a résumé of the history of a case taken from the above category.

Mrs. L. was a moderately advanced case of tuberculosis upon entrance. She suffered from a persistent slight elevation of temperature during an interval of more than two months, when the temperature assumed a more irregular tendency with a range of from 97.6° to 103.4° F. Coincident with the latter period were short alternating attacks of constipation and diarrhea. Marked nausea and gaseous distention of the intestines were present, accompanied by

frequent and severe pain in the left lower abdomen attributable to the accumulated gas. The appetite was poor and the usual nourishment was refused.

Shortly after the acceleration of temperature and the onset of the above intestinal symptoms, lactic acid soured milk was prescribed and so well tolerated that for two weeks the patient took no other nourishment of any kind. Gradual improvement began, and continued until the symptoms had sufficiently abated to justify a return to the regular hospital light diet, supplemented by the buttermilk. Immediately following the cessation of buttermilk, however, the same gastrointestinal disturbances returned. The temperature eventually returned to normal and the general condition improved, until the patient registered a total gain in weight of 32 pounds during her stay.

Another instance which exemplifies the apparent dependence upon the buttermilk diet developed during the course of its employment is the case of Mr. J. Originally prescribed for the relief of certain intestinal symptoms, Mr. J. has been taking the lactic acid milk for several months past. He complains of very little gastrointestinal disturbance so long as this treatment is continued, but upon cessation for a few days only, diarrhea and general discomfort appear.

It must be frankly admitted, however, that all cases are not attended with the degree of success that the above illustrative cases might suggest. Indeed, as previously indicated, there are patients for whom a continued employment of a buttermilk diet might be conducive of positive harm. Whilst their character is not clearly determined at present, cases of hyperchlorhydria may be mentioned as a type belonging to this unfavorable class.

However, failure is recorded even in individuals not very different from the illustrative cases recorded above. For example Dr. T. — a dentist — has suffered from persistent diarrhea, with flatulence for two or three months. The

buttermilk diet prescribed at this juncture was attended with complete failure, and after a fair trial was abandoned in favor of an autogenous *Bacillus Coli Communis* Vaccine. Improvement began as soon as the size of the dose was successfully regulated, and, under the continued use of this treatment, the symptoms remained controlled.

In laryngeal tuberculosis, and particularly in that dreaded form characterized by the involvement of the epiglottis, deglutition is often accomplished with considerable difficulty and accompanied by severe pain. Solid food is commonly interdicted, and an exclusive liquid and soft diet required. Here the lactic acid soured milk is frequently a grateful change from the dietary monotony of ordinary milk, which constitutes the essential element of such a diet; and it is doubly acceptable to the patient through the mild local stimulating action of the lactic acid contained.

That a liberal percentage of our moderately advanced and advanced cases suffers from chronic mucous gastritis is indicated both clinically and by a relatively large number of laboratory reports. The lactic acid element may here account at least in part, for the beneficial results obtained, but its application is by no means restricted to those individuals in whom complication is a factor, for the fact of its representing the full butter fat content of whole milk gives it a decided dietary usefulness as well. There are patients in whom the constipating tendency of ordinary milk either limits its employment, or wholly forbids its use, and there are many to whom its taste becomes unbearable after a time. Here the buttermilk may be substituted, in whole or in part, provided there are no contraindications to its use.

What of the patient, however, who is intolerant of the taste of buttermilk, and yet in whose case the application of lactic acid therapy is desired? It was formerly our habit here to prescribe one of the preparations of lactic acid bacilli tablets, widely advertised. Among their numerous disad-

vantages, however, are their high cost and the fact that the number of contained lactic acid bacilli alive and capable of subsequent multiplication in a suitable environment is ridiculously small. Indeed, during the course of certain experiments carried out in the sanatorium laboratories in connection with the various market preparations, it was a common experience to find a very large percentage entirely sterile, when macerated in normal saline and incubated at suitable temperatures, in various media best adapted to their growth. At the suggestion of one of the writers ordinary skimmed-milk cultures were substituted for the tablets, according to the following plan. After substituting sterile corks for the ordinary cotton plugs, the labels are marked with a future date — as indicating the time when the contained organisms might be assumed to have produced sufficient acid to affect their viability, and when the cultures, therefore, are to be renewed. The six ounce bottles containing the cultures are sent from the laboratory to the pharmacy ice-chest, and from there distributed to the various wards as required. Here the cultures are kept on ice, and for use a dram or more of the buttermilk is stirred into a few ounces of solution of milk sugar, care being exercised to avoid contamination of the stock supply. The ingestion is thus insured in a suitable carbohydrate medium — an essential accompaniment² lacking in the case of the tablets of many more live, active lactic acid bacilli than a dozen tablets could under the most favorable circumstances supply. The taste of the mixture is at most no more objectionable than that of the average prescription, in which a sirupy menstrum is employed.

Mention has been made in the preceding paragraph of the preparation in the laboratory of the cultures employed. If there is any lesson which a three years' experience has clearly emphasized it is the unqualified fact that only in the hands of a competent bacteriologist, and in an adequate laboratory,

is it practicable to carry out upon a hospital scale, and particularly in an institution of this character, the treatment we have outlined. During our early experience when the requisite supply was considerably smaller, the actual starter only was prepared in the laboratory, and the succeeding details of buttermilk preparation left to the worker in charge of the Centre Diet Kitchen, from where the larger percentage of trays for the bed patients are sent out. The milk was pasteurized in two quart milk bottles by placing in luke-warm water contained in saucepans of large diameter, and slowly raising the water to the boiling point upon the kitchen range. The milk was inoculated after cooling, with a portion of the original starter, and incubated in a warm place over night. On the second and succeeding nights a cupful or more of the resulting buttermilk replaced the laboratory starter and this procedure was continued for a four or five days' interval, after which a regular starter was again employed. It must be here admitted that the unfavorable character of the lactic acid bacillus was in part responsible for the unsatisfactory nature of the results obtained. The resulting buttermilk was frequently inferior and whole lots were commonly discarded because of the overgrowth of various resistant organisms which escaped death during pasteurization, and which were a part of the original bacterial content of the milk employed. At times the milk actually exhibited a fecal odor due to the overgrowth of certain members of the colon group. Examinations of samples of the buttermilk used for perpetuating the process often failed to show the presence of any of the milk-souring organisms contained in the original starter, and even after the use of a daily pure culture as a starter and lengthening of the period of pasteurization to as much as two hours, the results were not greatly improved. Substitution of various makes of so-called "lactic acid bacilli tablets" gave even worse results. It may be readily surmised that

the nauseating effect of a single glassful of milk bearing a fecal odor and thickened as a result of early peptonization by one of the spore bearers of the liquefying group was sufficient to prejudice patient and doctor against any further application of such a disgusting diet.

It may be profitable at this juncture, because of its important practical bearing upon the subject of the home preparation of buttermilk, to indicate briefly the principal factors which made for failure in the pursuance of the foregoing regime.

The factor of first and highest importance, as has been previously mentioned, was the absence of a biologically active culture of the milk-souring bacillus, capable of producing at room temperature, — 70° F. — when implanted in reasonably small numbers, in a milk medium, a growth of sufficient activity to inhibit by the free production of lactic acid the development of such organisms as are originally present in the milk, and escape death during subsequent pasteurization. This is a requirement to which very few strains of lactic acid bacilli can conform. It is our opinion and has been our experience, that only through the process of subculturing for a considerable period in a milk medium at the required temperature, can a given strain of lactic acid bacilli, carefully selected at the beginning, be educated to the point of producing a sufficiently free growth, accompanied by an adequate liberation of lactic acid, for employment in the routine production of buttermilk. Repeated strains obtained through the various commercial sources have failed of utility because of their noticeable feebleness of development.

The possession, therefore, of a strain of lactic-acid-producing organisms conforming to the above requirements may be regarded as the *sine qua non* of successful buttermilk preparation. That there is a wide variation among the various members of the so-called "Lactic acid group" in

biological activity as well as in morphological and in other characteristics is a fact familiar to every agricultural bacteriologist. The ability of the various spore-bearing peptonizers, and even certain members of the colon group, to resist active pasteurization, need not be emphasized, but the fact is less commonly recognized that occasional lactic acid organisms may remain viable after an exposure to 166° F. for as long as 30 minutes³, and subsequently give rise either by their symbiotic development in connection with the lactic acid strain introduced, or by their more rapid individual development to a form of lactic acid fermentation differing materially and unfavorably from the anticipated variety. This experience has been repeatedly if not commonly encountered in our earlier work, and from the foregoing it will readily appear that simple pasteurization, however conscientious, cannot be depended upon to insure constant exemption from the multiplication of undesirable organisms. The peptonizers invariably escape destruction, and whilst present, as a rule, in comparatively small numbers, their growth depends only upon a temperature unfavorable to the free development of the lactic acid bacteria, — from 75° to 98.6° F. or below 60° F., — and favorable to their own activity. Indeed this very matter of temperature variation during the period of incubation is second only in importance to the character of the "starter" employed.

The usual directions are to place the milk in a warm place over night, following inoculation. The diet kitchen in which our buttermilk was formerly incubated is steam-heated and equipped with a range in which the fire is allowed to smolder during the night, so that the thermal conditions may be regarded as average ones. The variation by actual determination was considerable, — 60° F. and 80° F. representing the two extremes, — as influenced largely by the weather conditions and the exact spot selected for incubation.

Now the universal souring of milk as a matter of daily and domestic occurrence is largely dependent upon its common exposure to a temperature approaching 70° F., since the number of lactic acid bacteria present in recent milk is relatively small, as compared with the total bacterial content.⁴ As low as 10 per cent is given as an authoritative figure by recent experimenters. When the temperature at which milk is stored exhibits any considerable variation in either direction we encounter the possibility of a preponderance of either the peptonizing, alkaline, neutral or colon group, dependent upon the degree and direction of the variation.

If any doubt is entertained in this respect the simple experiment of incubating aliquot parts of a fresh sample of milk, one each, in the thermostat, in the gelatine incubator, in a cool room and in the ice-chest will afford a convincing illustration.

Briefly then, the factors which render impracticable the preparation of large quantities of buttermilk under what may be termed home conditions may be summarized as follows: —

First and of probably the highest importance is the difficulty in obtaining a reliable strain to be used as a starter.

Second. — The fact that certain undesirable organisms, — even lactic-acid producers, giving rise to an unsightly buttermilk of unpleasant taste; may, under favorable temperature conditions, multiply at the expense of the bacteria introduced.

Third. — The difficulty of maintaining in the home, a fairly constant temperature of about 70° F.

Fourth. — The fact, not previously mentioned, that when the at-present-rather-extensively-employed Bulgarian bacillus is used a temperature close to 98.6° F. is necessary, and that even when the milk is successfully soured by this bacillus, the resulting excessive acidity, and the almost sirupy, sticky consistency of the milk, is obnoxious to most

patients. If employed in connection with the *Streptococcus Lebenis*, the latter fails to actively develop at the temperature required for incubation of the *Bacillus Bulgaricus*, and, if exposure to 70° F. is employed, the streptococcus becomes the principal factor, the Bulgarian bacillus developing feebly, or not at all. As a matter of fact, in actual practice the *Streptococcus Lebenis* soon dies out, leaving behind its more resistant companion.

Fifth. — In all hospitals and particularly in those for the care of the tuberculous, the opportunity for infection of the milk subsequent to pasteurization, with pathogenic bacteria — tubercle bacilli from tuberculous employees, diphtheria bacilli, possible typhoid carriers, the streptococci of epidemic sore throat, etc. — at the hands of individuals without bacteriological training, although admittedly slight, is by no means an inconsiderable one.

Having reviewed the difficulties in the way of butter-milk preparation, and the reasons for our transferring the entire process from the diet kitchen to the laboratory, an outline may be offered of the method employed at the Rutland State Sanatorium during the past three years.

We owe free acknowledgment at this point to the generosity of Dr. Leon S. Medalia, from whom our present most extensively-used lactic acid bacterium was obtained.

After numerous experiments with various strains of so-called lactic acid bacteria, obtained from various commercial and laboratory sources, as well as isolated from different specimens of soured milk and dairy buttermilk, the Medalia Bacterium⁵ remains by all odds the most generally satisfactory one encountered to date. Its superiority may be accounted for, at least in part, by the fact that it has been passed through innumerable milk subcultures, during a period of more than three years.

Incubated over night at 70° F. in a whole milk medium, it produces a smooth buttermilk, of creamy consistency,

and moderately acid taste. The average acidity of the finished product, in terms of lactic acid as we have determined by frequent analyses, is 0.6077 per cent. If a more sharply acid content is desirable incubation may be extended a few hours further, but care must be exercised to avoid the production of sufficient acid to affect the viability of the specific bacterium contained. It is the habit of the nurses when dispensing the beverage to pour it from the containing flask into a deep aluminum cup and churn to a fine emulsion with an egg beater. This simple expedient insures the breaking up of the coarser particles, and an exceedingly smooth, creamy buttermilk results.

To guard against possible loss of the organism stock cultures of skimmed-milk, azo-litmin-gelatin, calcium carbonate-dextrose-bouillon and gelatin-glucose-agar are stored in the ice-chest, after the attainment of a free development; and transplanted at intervals of about every two weeks. For the practical purposes of buttermilk production a milk medium alone, in four main varieties of containers, is employed. Since we average more than six gallons of buttermilk daily, from a half liter to a liter of milk culture is necessary to carry out the inoculation of the various flasks. Two sets of 500-c.c. flask-shaped gas bottles are in constant use.

In the Centre Diet Kitchen the empty flasks, after thorough washing with soap powder and ammonia, and rinsing in boiling water, are filled in the early forenoon with fresh whole milk to a degree which admits of comfortable shaking after subsequent addition of about 25 c.c. of fluid. The flasks are then stoppered snugly with rolled surgical-absorbent-cotton plugs, and carried on a metal tray to the laboratories where the previous day's accumulation, having been converted over night into buttermilk, awaits removal to the ice-chest. The flasks are immediately transferred to the steam sterilizer where they are subjected to a temperature

of 212° F. for 1½ hours. The actual preparatory sterilization of the milk needs no apology in view of the facts already outlined. The taste of the finished buttermilk, contrary to the general contention, is but slightly affected and there is much satisfaction in the knowledge that prior to inoculation the milk contains in the way of live bacteria only a few spore-bearing organisms, which probably succumb to the heightened acidity as soon as the lactic acid content approaches the neighborhood of 0.60 per cent.

After sterilization the milk is cooled as rapidly as possible to about 70° F., and set aside at that temperature, protected from dust by covering over with clean towels until about 5 o'clock in the afternoon. The cotton plug of each flask is then burned off, removed and about 25 c.c. of a pure 24 hours' culture of the lactic organism introduced. A sterile cork stopper is inserted, the contents thoroughly shaken and the cotton plug replaced. The cork stopper is thus carried from one container to another, saving the cotton from soiling during the mixing process. The usual bacteriological precautions must of course be carefully observed. The flasks are then stored, covered over as previously, in a protected place in the inner chemical laboratory where it has been found that a very constant temperature of about 70° F. is maintained. About 8 o'clock on the following morning the milk will be found to have thickened into an even almost solid coagulum, there being no perceptible whey. The flasks are again actively agitated, when a thick, even, creamy emulsion results. The finished buttermilk is then transferred at once to the diet kitchen refrigerators, and thoroughly chilled before use. A word regarding the matter of containers may be useful at this point. Formerly it was our habit to employ empty bottles of from 500-c.c. to a liter capacity, of whatever character available, provided they fitted into the sterilizers. It was found that breakage during sterilization was an altogether too common experience,

and a supply of 500-c.c. flasks of resistant material, known to the chemist as gas bottles, was obtained. These serve an additional purpose as will presently appear.

For the routine handling of stock cultures in the laboratory three varieties of containers are necessary, fresh separator-skimmed-milk being the medium employed. At least four and preferably five days' sterilization by the fractional method, with a daily exposure of 45 minutes, is essential to escape subsequent overgrowth by the spores of extremely resistant organisms originally present in the milk, with all the troublesome contaminations which such occurrences entail. They may fail to develop during storage of the media in the ice-chest, but appear upon incubation, and possibly spoil an entire lot of buttermilk. A safe guide, useful in our experience, is the caramelization of the milk sugar, which only occurs, as a rule, after long and repeated sterilization at 212° F. — usually upon the fourth or fifth day. The media is prepared, according to the above directions, in ordinary culture tubes, in four ounce round prescription bottles having a mouth of medium diameter and in flasks similar to those used for the buttermilk.

The culture tubes serve to keep alive and perpetuate the bacterium in the laboratory, and are transplanted each day — several being kept in reserve. The contents of the tube of least recent date, after emulsifying with a little sterile normal saline to facilitate pouring, are distributed among as many flasks and bottles as may be required for use on the wards in the case of the latter — or for starting the next day's buttermilk. These details are carried out late in the afternoon and the culture tube, flasks and bottles set away in the incubator over night. In the morning the milk will be found to have reached the desired degree of thickening, and all containers are transferred to the ice-chest to prevent further development. Were the cultures kept at incubator, or at room temperature, sufficient acid to

kill off the specific bacterium would soon be elaborated. Indeed a refrigerator may be regarded as absolutely indispensable to the successful operation of this or any similar bacteriological plan.

It will readily appear, that to guard against contamination of the milk, the greatest care is imperative in a laboratory where the handling of typhoid bacilli, and all sorts of pathogenic organisms and pathological material is a part of the day's routine.

For greater security the rule is observed in dealing with the lactic acid organisms of having the table free at the time from all other cultures, and distinctive sized culture tubes, as well as a special platinum inoculating needle devoted exclusively to this purpose, are employed. Prior to fractional sterilization the stock culture flasks after tubing and plugging are covered over, as shown in the photograph, with a square of cotton cloth, secured by means of a rubber band. This precaution has been found useful in preventing the entrance during storage or during subsequent incubation of extraneous bacteria or troublesome spores. In the case of the culture bottles the necks and stoppers at the time of inoculation, after flaming the cotton, are secured by means of an ordinary paper prescription-bottle cap.

For the information of the prospective worker with this particular strain of bacteria, — designated as "The Bacterium Acid Lactici, Medalia" in the Sanatorium Laboratories, — a word in conclusion is offered regarding a few of its biological and morphological characteristics. It grows satisfactorily but not abundantly on the usual media, ferments carbohydrates with the production of acidity, is gram-positive in its staining reaction, is nonmotile and does not, of course, form spores. In milk, coagulation occurs somewhat earlier than usual — in the neighborhood of 0.6 + per cent; and above 0.7 + per cent an undesirable breaking up of the original coagulum is apt to result. On agar

and in 2 per cent dextrose-bouillon, development is fairly active; and through a little overincubation, or a brief sojourn outside the refrigerator, the production of a fatal degree of acidity easily occurs. The simple expedient of adding 1 per cent precipitated calcium carbonate to the glucose-bouillon affords the most useful medium available for storage of the bacterium. It is identical with the method of Hiss ⁶ which we employ in dealing with liquid cultures of the pneumococcus, and depends upon the neutralization of the nascent acid by the alkaline carbonate.

An important detail in connection with the organism in question is its pleomorphism, which is so marked at times as to present to the uninitiated the idea of contamination. The usual form is that of a short diplobacillus with somewhat tapering extremities, suggesting at a casual glance the morphology of extreme types of the pneumococcus. The less common shape is a frank bacillus, from twice to several times the size of the above, in length and diameter. At the time of our first acquaintance with the present strain it was thought that we might be dealing with two closely related organisms, but subsequent carefully repeated plating established at once its unity and its pleomorphism.

No doubt there are many other lactic acid bacteria which are proving equally as active in the hands of other investigators. It may be remarked in connection with the present report that nothing has been said with regard to the practical bacteriological proof of the establishment as a more or less persistent inhabitant of the intestinal mecosa of the bacteria in question, but it must not be inferred that evidence of such occurrence is altogether lacking. Work has been undertaken along these lines, and although the present results are too slight for emphasis at this time it is hoped that at a future date something definite may be offered.

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ARTICLE XXI.

EXPERT TESTIMONY

BY MR. WILLIAM G. THOMPSON
OF BOSTON.

AN ADDRESS DELIVERED AT THE ANNUAL DINNER OF THE
SOCIETY, JUNE 12, 1912.

EXPERT TESTIMONY.

MR. PRESIDENT AND GENTLEMEN OF THE MASSACHUSETTS
MEDICAL SOCIETY:

A lawyer who has an opportunity to address doctors feels, I suppose, something like the patient and client of a certain member of your profession whom I had the pleasure of cross-examining not long ago. The doctor had diagnosed the case as Coccygodynia. Upon being pressed for an explanation of the origin of that name, he testified after some hesitation that it was derived from the name of the leader of Coxey's army because of the incapacity of persons suffering from the disease to sit still.

I regard your President's invitation to address you this evening as a great honor. I hope you will not feel that I am abusing the privilege if I say a few words to you on the perennial subject of expert testimony.

At no time during the twenty years that I have been practicing law has criticism of the courts of this country been so general and sweeping. We may congratulate ourselves that our Massachusetts courts have almost wholly escaped this flood of adverse criticism. Indeed, they have even received some faint praise from the great advocate of the recall of judicial decisions. But one charge they have not escaped — the charge of inefficiency in dealing with expert testimony; and that charge is backed not only by popular opinion, but also by the opinion of scientific men. And it cannot be denied that that charge is to a certain extent justified.

Before mentioning to you the direction in which I think a remedy may be found, I want to ask you to notice that in

all this attack upon the courts, there is apparently one idea and only one upon which all the critics agree. That idea is that for some reason or other the courts are out of touch with the realities of life; or, to put it in another way, that while the judges' knowledge of legal principles is sufficient, their knowledge of the facts of modern life to which those principles are to be applied is inadequate in the sense that it ignores the interpretation of natural phenomena by modern science, and of social phenomena by modern sociology. In a word, it seems to be believed that the courts and the people are living in different worlds.

For instance, our constitutions contain large eighteenth century affirmations of certain natural rights of men — rights to life, liberty and property, and to the pursuit of happiness. None of those affirmations are exact. All of them require interpretation. The complaint is that some appellate tribunals are still interpreting eighteenth century affirmations in the light of eighteenth century knowledge and conditions, making, for instance, a fetich of the right to contract, so that employers are enabled to require workmen to labor under unsanitary conditions, or for excessive periods.

Now, in the matter of expert testimony the complaint made by honest and competent physicians is similar. It is not so much that the conclusions to which they testify are not always accepted. It is rather that the tribunal appears not to comprehend their methods of reasoning. It has apparently no facilities for weighing rationally honest differences of expert opinion, or for discriminating authoritatively between honest and dishonest differences of opinion; and it is urged that the lack of such facilities is especially unfortunate where scientific truth is made the subject of a partisan controversy between litigating parties, and where the whole truth is likely to hurt one or the other, and perhaps both.

Now, admitting that this criticism is to a certain extent

justified, let us see what can be done about it. There are two different ways of dealing with such a situation. The first is by legislative interference, that is, by the enactment of rules dealing with the qualifications and the number of expert witnesses, and perhaps creating a body of official experts. The other is by looking to the judges themselves for the reform, and by taking steps to secure men with the necessary qualifications to bring it about, trusting to that inner power which common law tribunals have usually displayed when properly led and sufficiently unhampered by legislative interference, to adapt themselves to the changing conditions of society. The latter is, in my opinion, the alternative which holds out the only hope of permanent improvement.

All of us presumably desire to live under what the Massachusetts constitution calls a government of laws and not of men. But what does that mean? It means simply that the rules of conduct * called laws shall be general in form, and that they shall be so administered that no particular case which logically falls within them shall escape them, and that no particular case not logically falling within them shall be affected by them. A trial at law when reduced to its simplest terms is nothing more than an announcement by the judge of the appropriate general rule, whether drawn from the statutes, or from the common law; a finding by the jury whether the particular case falls within or without that general rule; and a recording of the conclusion by the clerk in the form of a judgment. In other words, every trial may be reduced to a syllogism in what the elementary text books used to call the first figure, commonly illustrated by the statements: "All men are mortal; Socrates is a man; therefore Socrates is mortal." You see if there is any caprice or mistake on the part of the judge in laying down the

* The expression "rules of conduct" is, of course, loose. It is believed, however, to be sufficiently accurate for the purpose in hand.

general rule of law, which is the major premise, or any mistake on the part of the jury in determining truly, affirmatively or negatively, the minor premise, government by law is in that case and to that extent defeated.

Now, it is with the determination of the minor premise that expert testimony is concerned. The mind which has always determined and must continue to determine the minor premise is the mind of the jury. The problem is, therefore, how to secure on the part of the jury a sufficient comprehension of scientific reasoning, and a proper respect for scientific conclusions. Can it be done by establishing boards of official experts? That implies giving to the opinions of a few men upon every conceivable question of medical science that may arise in a lawsuit the stamp of governmental approval. Is the medical profession prepared to take the position that all differences of opinion between doctors upon professional subjects are due either to ignorance, partisanship, or mercenary motives on the one side or the other, and that physicians fit to be the authorized spokesmen of the medical profession upon every question of medical science that may ever be brought in issue in a lawsuit can be selected by any method feasible in this community? Is the profession really willing to permit any particular professional views to be stereotyped with the stamp of governmental approval? These questions, I should suppose, admit of but one answer. Medical science is not a closed book. It is alive, and not dead; and the principal sign of life is the constant discussion and difference of opinion that accompany investigation and research.

If, then, there be such a thing as a legitimate difference of opinion among medical men on questions of fact involved in a lawsuit, we have no right to deprive either party of the benefit of the particular opinion which favors his contention. If we admit that, we also admit that those differences of opinion must be submitted to the decision of the jury.

And if we admit that, then the problem is simply to provide some means by which the jury may be enabled to weigh conflicting medical opinions rationally, and not capriciously or ignorantly.

Now, the English people, from whom our judicial system is derived, have solved this problem with a fair degree of success. That the solution should be perfect cannot, of course, be expected. But they have discovered what we have not discovered, that an efficient administration of law depends most of all upon the ability, vigor and enlightenment of the judge. Long before the great advance in scientific knowledge, questions of fact arose in lawsuits too difficult to be successfully dealt with by juries if assisted only by the partisan lawyers on either side; and in such cases the English tradition always expected the judge to assist and advise the jury, he being the one official possessing both impartiality and a trained mind. True, the advice was not always as valuable as it seemed at the time. Some of the most learned English judges who ever sat on the bench presided gravely at witchcraft trials, and gave to juries advice about pin prick tests which would hardly be accepted by the modern neurologist. But usually the power was wisely exercised with beneficial results. That power is almost universally withheld by statute or by constitutional provisions from the judges of the courts of our American States, including this Commonwealth.

But that power is more needed to-day than ever before. The reason is that the enormous advance in scientific knowledge during the last century has brought within the domain of science countless questions of fact which before were supposed to be entirely within the grasp of ordinary knowledge or of what is called common sense. That fact is, of course, the very reason for the great development of expert testimony itself. Democracy has been forced grudgingly to admit that there is knowledge not dreamed of in its philos-

ophy. But in this country, at least, it retains its dislike of the expert, and, while willing to receive his conclusions, is as yet unwilling to admit that his methods of reaching those conclusions may be superior to the methods of so-called common sense, or beyond the unassisted grasp of the twelve representatives of democracy who sit in the jury box. Nor will they permit the judge to interfere. The expert is, therefore, left to the tender mercies of counsel. The right of cross-examination, which is essential to the detection of dishonesty and ignorance, is used to belittle the expert in the minds of the untrained jurymen. His motives are questioned, his methods of reasoning are held up to ridicule, and his testimony is thus unfairly discredited.

But it would be a serious mistake to suppose that all that is necessary is to restore to the judges power to advise juries upon matters of expert testimony or upon questions of fact generally. One thing more is necessary, and perhaps it is the most important of all. That is to insist that judges shall be selected who possess the necessary qualifications to enable them to act as the interpreters of the world of science to the world of common sense. It seems to me that we have reached a point where we must revise our conception of the necessary qualifications for the bench. We cannot of course, insist that the judge should be a specialist in any department of science. But we ought to insist that in addition to learning in the law, analytic power, and force of character, he should have that familiarity with the methods and spirit of scientific inquiry which is a necessary part of a liberal education in the modern sense. He must understand the methods of inductive reasoning. He must understand the language of men of science. We probably have some such judges on our Superior Court. How many it is difficult to tell, so long as they are all alike muzzled by statute.

If what I have said is sound, then the direction in which true reform is to be sought is plain. We should seek first

a repeal of all statutory restrictions upon the ancient power of the judges to deal freely with the facts; secondly, we should seek to create a public sentiment favorable to the exercise of that power; and finally, we should insist that no man shall be appointed to the bench who has not that familiarity with the methods and spirit of scientific inquiry which makes a man a cultivated man in the modern sense of that term. When this is accomplished, and not before, shall we be able to write over the doors of our court houses the words of the great Greek dramatist, "Thou hast seen our ordered life, and justice, and the long still grasp of law not changing with the strong man's pleasure."

SEVENTH ANNUAL REPORT
OF THE
ASSOCIATED COMMITTEES
OF THE
MASSACHUSETTS MEDICAL SOCIETY
FOR THE
PREVENTION AND CONTROL
OF
TUBERCULOSIS.



JULY 1912.

REPORT OF THE CHAIRMAN.

It is generally agreed that the care of indigent consumptives in hospitals during the late stages of the disease is the most effective means of limiting the spread of consumption. It is also a matter of experience that in order to keep hopeless patients in hospitals it is important to have these hospitals near their homes so that they may not be cut off from their families and friends. Local hospitals are then a prime need in any earnest effort to control tuberculosis.

The law prescribes such hospitals for all communities of any size. This legislation can only be made effective in a community where the public takes an interest and is determined to have this measure of protection thoroughly carried out.

There are now cities in the State where the hospitals exist and the law is thus conformed to, but where the Boards of Health and the physicians do not send the patients into the hospitals and the community is thus robbed of the protection that it ought to have. Here is a matter that should be under the especial care of the medical profession. They should see to it that the public understands the situation and is informed as to the failure of the Board of Health to provide all possible protection.

To one who has kept in close touch with the situation throughout the State it is interesting to see that the communities which have accomplished most in this sort of protection are the very ones in which the physicians have aroused themselves and taken an active part in the campaign.

Every member of the Associated Committees — in fact every member of the Massachusetts Medical Society — should lose no opportunity to help this movement for sufficient hospital accommodation.

What now has been done and what progress has been made in the past year.

At the beginning of the year, Boston, New Bedford, Lawrence, Salem, Brookline, Westfield and Somerville had established tuberculosis hospitals. In some of these the provision of beds was quite adequate to the need; in others the number of beds was quite out of proportion to the number of patients that should have been provided for.

During the year the following additional accommodations have been provided:

Pittsfield has maintained a permanent camp and now has a farm upon which it proposes to establish a regular tuberculosis hospital. Fall River is planning a large municipal hospital. Lynn has completed a hospital of 50 beds. Holyoke has completed a hospital of 25 to 30 beds. Springfield has a hospital of 12 beds. Cambridge has a hospital providing for 75 or 80 patients. Waltham has established a hospital which can accommodate 17 patients.

In addition to these the following places are taking active steps towards procuring hospitals.

Quincy, which for almost two years has had a small permanent camp, is proposing an enlargement of this to give proper hospital accommodations to an increased number of patients. Adams is planning a hospital in connection with its very efficient day camp. Haverhill is planning for a hospital and so also are Newburyport and Fitchburg.

In the southern districts Brockton is considering plans for a hospital but has taken no decided step as yet.

There are still many places unprovided and apparently indifferent about making provision, where the medical profession ought to push on the people and the health authorities.

In addition to the law passed in 1911 requiring each city and town of over 10,000 inhabitants to build and maintain a hospital for consumptives an act was passed requiring similar cities and towns to establish and maintain tuberculosis dispensaries.

Certain cities, notably, Boston, Cambridge, Fitchburg, Gardner, Salem, Fall River and Springfield, had already complied with the spirit of this act prior to its passage. Very few boards of health, however, since the passage of this act, have taken any active steps toward meeting its requirements. Brockton, which had maintained a dispensary under the auspices of the local tuberculosis association, turned this over to the board of health. Gardner had already done this. The board of health of Brookline has recently opened a tuberculosis dispensary. There are very few other instances, however, in which anything has been done in this most important line of work.

The medical profession should everywhere see to it that local boards of health are complying with this act and should be ready and willing to offer their professional services to further the work of such clinics.

The medical inspection of schools and factories is still far from what it ought to be. Although the idea of fresh air rooms and outdoor schools has met with a favorable reception in this State, efforts in this direction are liable to die out unless the physicians do their duty in arousing and keeping aroused a strong public opinion in favor of a thorough and adequate medical inspection of school children and particularly in favor of the appointing of school nurses.

The same might be said in regard to the medical inspection of factories and workshops. Here again much has been accomplished during the past year in arousing public sentiment, but here also the medical profession must constantly be on its guard to see that this sentiment does not die out.

ARTHUR T. CABOT, *Chairman.*

REPORT OF THE SECRETARY.

MEETING OF THE EXECUTIVE COMMITTEE.

FEBRUARY 29, 1912.

A MEETING of the Executive Committee of the Associated Committees of the Massachusetts Medical Society for the Prevention and Control of Tuberculosis was held at 3 Joy Street, February 29, 1912, at 3.45 p.m.

Present: Drs. Cabot, Chase, Hawes, Jackson and Worcester.

The chairman brought up for discussion the subject of the reorganization of these committees and the urgent need of appointing on each local committee the men who are really active in tuberculosis work.

At the suggestion of Dr. Hawes, the following vote was passed.

Whereas there are many physicians who are active in antituberculosis work who are not members of the Associated Tuberculosis Committees, and

Whereas there are many physicians who are members of these committees who are not taking any active part in the work, it is

Voted, That the Executive Committee write to the secretary of each district medical society and call attention to these facts, and suggest that changes and additions be made in the personnel of each local committee.

The question was next brought up for discussion as to the advisability of printing the annual report in separate form. After discussion it was

Voted, That the annual report be condensed as much as possible and be made an accurate summary of work actually done and that it be printed along with the proceedings and annual report of the Massachusetts Medical Society.

The chairman then brought up for discussion the question as to the advisability of having printed and sent to each

member of the Massachusetts Medical Society a copy of the article by Dr. Hawes on "The Responsibility of the Medical Profession for the Prompt and Early Diagnosis of Pulmonary Tuberculosis." It was

Voted, That copies of Dr. Hawes' article be printed and distributed to the members of the Massachusetts Medical Society, provided that this article meet with the approval of Drs. Chase and Jackson. (This was provided for by private subscriptions.)

The program for the annual meeting was then discussed. Dr. Cabot suggested that in view of the fact that at the last two meetings the sociological and economic side of the tuberculosis question had been discussed, it would be well to devote this coming meeting to a consideration of the scientific and clinical aspects of the question.

After discussion it was agreed that the program for the annual meeting of the Associated Committees be of a scientific rather than a sociological nature, and to endeavor to secure papers on the subjects of treatment, tuberculin, auto-inoculation, etc.

Adjourned at 5 P.M.

JOHN B. HAWES 2d,
Secretary.

MEETING OF THE COUNCIL.

JUNE 11, 1912.

A MEETING of the Council of the Associated Committees for the Prevention and Control of Tuberculosis was held June 11, 1912, at 2 P.M.

Present: Drs. Adams, Cabot, Jackson and Hawes.

It was *voted*, To dispense with the reading of the minutes of the last meeting.

The Chairman, Dr. Cabot, announced that at the meeting of the Council of the Massachusetts Medical Society it was voted to authorize the formation of a tuberculosis section

in addition to the medical and surgical sections of the Society. On motion of Dr. Adams, it was

Voted, That the present officers of the Associated Committees be reëlected for the ensuing year — Dr. Arthur T. Cabot, Chairman, Dr. John B. Hawes, 2nd, Secretary.

Adjourned at 2.30 P.M.

JOHN B. HAWES, 2nd,
Secretary.

REPORT OF DISTRICT COMMITTEES.

BARNSTABLE DISTRICT.

The work in this district has been directed mainly toward seeing that all cases of tuberculosis are reported promptly. The greater part of the work has consisted of individual efforts on the part of members of the committee. The people are responding to this influence as shown by their ready coöperation to help whenever a need arises.

No new association has been formed or hospitals or dispensaries opened.

BERKSHIRE DISTRICT.

The anti tuberculosis associations have continued their work in Pittsfield, Adams and Great Barrington. A new association has been organized in Williamstown. The day camp at Adams was closed during the winter and is now open for the summer again. The Pittsfield tuberculosis camp was kept open all winter. The Pittsfield Association has purchased the farm of 53 acres and has plans for increasing the facilities. The camp was opened July 20, 1911. From that time till the end of the year, May 1, there have been 37 patients at this camp.

BRISTOL NORTH DISTRICT.

The activities of this district have consisted in the work of the local anti tuberculosis societies in Attleboro and Taunton. No new hospitals or dispensaries have been established or associations formed during the past year.

BRISTOL SOUTH DISTRICT.

Fall River.

The Fall River Anti Tuberculosis Association has been active during the past year. The society maintains a regular visiting nurse and paid secretary. Public clinics have been held once a week as before. The city of Fall River is planning a large municipal tuberculosis hospital which will be of the greatest help in meeting the local problem.

New Bedford.

The anti tuberculosis work in New Bedford is in the hands of the local Board of Health, which maintains a well organized dispensary, the Charity Organization Society, and the New Bedford Sanatorium. This institution has been approved under the Subsidy Act and takes care of a large proportion of New Bedford consumptives.

Excellent work has been done at St. Luke's Hospital in the care of cases of surgical tuberculosis.

The District Nursing Association coöperates with the other organizations in the care and instruction of patients taking home treatment.

The situation at New Bedford is a striking example of the good effect of perfect harmony and coöperation among all the forces striving to eradicate tuberculosis.

ESSEX NORTH DISTRICT.

Andover.

The tuberculosis work in Andover has continued during the past year under the supervision of the tuberculosis committee and its nurse.

Lawrence.

The Lawrence Anti Tuberculosis League has continued its work as in the past. At the Lawrence Tuberculosis Hospital there are 90 beds. There have never been over 35 patients there, however, many patients still preferring to go to the State sanatoria. This hospital has been approved by the State and receives a subsidy of \$5.00 per week per patient.

Haverhill.

The local tuberculosis society has continued its work during the past year. A municipal tuberculosis hospital is planned but has not yet been built.

Newburyport.

The tuberculosis society has kept up its work during the past year as before. A local tuberculosis hospital is contemplated but has not yet been built.

ESSEX SOUTH DISTRICT.

Lynn.

The anti tuberculosis society has kept up its work during the past year but has found itself in a somewhat embarrassing position owing to the formation of a new organization, the "Lynn White Plague League." This League has raised considerable money for the care and relief of persons suffering with tuberculosis, but aside from this has as yet framed no definite policy. The Board of Health has opened a new local tuberculosis hospital with 50 beds. This hos-

pital has been approved by the State Board of Trustees of Hospitals for Consumptives, and will be of the greatest help in relieving the local situation.

Salem.

The tuberculosis committee of the Salem Associated Charities has continued its active work along the same lines as before, having continued its day camp and dispensary. There is a small local tuberculosis hospital under the auspices of the Board of Health.

FRANKLIN DISTRICT.

Nothing new has been accomplished in tuberculosis work in this district during the past year.

HAMPDEN DISTRICT.

Chicopee.

The local tuberculosis work is in the hands of an active Board of Health. There is no local dispensary or hospital, the patients being cared for at the State Sanatoria.

Holyoke.

The Holyoke Tuberculosis Association has been active. Owing to the opening of the local municipal hospital, an excellently planned institution, accommodating about 30 patients, the day camp, in former years under the auspices of the local association, has been closed. Patients in the advanced stage of the disease are kept at this hospital, while those in the earlier stages, especially children, are sent to the State Sanatoria. The local hospital has been approved by the State under the Subsidy Act.

Springfield.

The Springfield Anti Tuberculosis Association has carried on the greater part of the anti tuberculosis work in this city.

The actual work has been in the hands of a nurse who has followed up cases returning from the State Sanatoria, and those taking home treatment. Weekly clinics have been held as before.

The Board of Health has opened a small tuberculosis hospital with 12 beds. This has been approved by the State. It is hoped that this will be but a temporary arrangement to last until a building with adequate accommodations can be constructed.

Westfield.

At the local tuberculosis hospital there are accommodations for six patients. This hospital is under the charge of the Board of Health and has been approved by the State.

HAMPSHIRE DISTRICT.

Northampton.

The local tuberculosis association has distributed circulars of instruction, has printed articles in the public press and is making progress in getting patients to consult physicians earlier than before. The association feels that the educational influence of patients returning from the State Sanatoria is beginning to make itself markedly felt in this city. There is no record of other tuberculosis work in this district.

MIDDLESEX EAST DISTRICT.

Winchester.

The Social Service and District Nursing Associations have been active in this town during the past year. There is no record of other activity in this district.

MIDDLESEX NORTH DISTRICT.

Lowell.

The Tuberculosis Committee of the Middlesex North District Medical Society holds a meeting four times a year: just

before the regular quarterly meeting of the district medical society.

The summer tuberculosis camp on the grounds of the Lowell General Hospital has been kept open during the past year. The District Nursing Association has been active. There are seven district nurses, who, along with their other work, have attended to many tuberculous patients. There is no local tuberculosis hospital and no dispensary.

MIDDLESEX SOUTH DISTRICT.

Cambridge.

Anti tuberculosis work in this city is in the hands of the Board of Health and the local association.

The local tuberculosis hospital has recently been improved and enlarged and has now been approved under the Subsidy Act. The dispensary, under the auspices of the local association, has been continued as before.

Malden.

The tuberculosis committee of the Malden Associated Charities has continued its work as before. A tuberculosis hospital has been planned but is meeting with considerable objection at the hands of property owners near the proposed site.

The Jewish Organization, the Malden Anti Tuberculosis Society, is doing good work among patients of this race, of whom there is a large number.

Somerville.

The Board of Health has continued its local tuberculosis hospital. The beds of this hospital have never been filled with Somerville patients but are used, by arrangement with the Boards of Health of nearby towns, to care for many of their consumptive patients.

Waltham.

The Waltham Board of Health has made arrangements with the Waltham General Hospital to care for its tuberculous patients in two special wards connected with this hospital. These wards have recently been approved under the Subsidy Act. There is no dispensary.

There is no report of any new work from Ashland, Belmont, Concord, Framingham, Holliston, Hopkinton, Hudson, Medford, Natick or Newton, the other towns and cities in this district.

NORFOLK DISTRICT.

The committee of the Norfolk District has done no work independent of that carried on by the Boston Consumptives Hospital, the Boston Tuberculosis Association and the Boston Board of Health.

Brookline.

The Board of Health has a small tuberculosis hospital with six beds. This is now closed for the summer. The Brookline Anti Tuberculosis Association has carried on its educational work as before, particularly among the school children. The Board of Health has recently opened a tuberculosis clinic one afternoon and evening a week with two physicians and a nurse in charge.

Canton.

The work here has been much the same as in previous years. Partial plans have been made for work among the school children, such as written compositions on prevention of tuberculosis, and it is hoped to carry them into effect at the opening of the fall term. Prizes are to be awarded. This is the only new venture so far.

NORFOLK SOUTH DISTRICT.

Braintree.

This city has up to date taken no steps toward building a local tuberculosis hospital or establishing a dispensary.

Quincy.

The Quincy Anti Tuberculosis Association, in conjunction with the local Board of Health, has changed its day camp into a permanent hospital with six beds. In addition to this the anti tuberculosis association has kept up its educational and relief work as in the past.

PLYMOUTH DISTRICT.

Brockton.

The Brockton Anti Tuberculosis Society has confined itself to educational work during the past year. Its dispensary has been turned over to the local board of health and had been continued as before.

A local tuberculosis hospital under the auspices of the board of health is planned but not yet constructed.

SUFFOLK DISTRICT.

Work in this district has been in the hands of the Boston Tuberculosis Association, the Boston Board of Health and the Boston Consumptives Hospital. Nothing has been accomplished by the committee as a whole but each member has been active in one or more of the organizations mentioned above.

Chelsea.

The anti tuberculosis work in this city has been in the hands of the board of health, which has continued its clinic and has been active in other ways. There is as yet no local tuberculosis hospital.

WORCESTER DISTRICT.

The city of Worcester is planning a large municipal tuberculosis hospital. The local association has continued its work as heretofore. There is no report of any new tuberculosis work from the other cities or towns in this district.

WORCESTER NORTH DISTRICT.

Fitchburg.

The city of Fitchburg is making arrangements with the Burbank Hospital to care for its consumptive patients in new separate wards. The local tuberculosis society has continued its active work as in the past.

Gardner.

The dispensary, originally established by the local association and later turned over to the Board of Health, has been continued as before. In addition to the physicians in charge the Board employs a trained social worker and nurse to look up and instruct all cases of tuberculosis.





